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A CONCISE SYSTEM
OF
PRACTICAL ARITHMETIC,
ADAPTED TO
The Use of Schools.

By J. MELROSE.

RE-ARRANGED, IMPROVED, AND ENLARGED,
With Tables and Exercises on Decimal Coinage
and the Metric System,

By ALEXANDER TROTTER,
TEACHER OF MATHEMATICS, ETC., IN EDINBURGH,
Author of "Arithmetic for Advanced Classes," "Key to Trotter's
Complete System of Arithmetic," etc.

Forty-fourth Edition.

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PREFACE TO NEW EDITION.

THIS concise System of Practical Arithmetic was designed by its Author to lead Pupils by an easy gradation from the simplest to the most difficult operations in the science of which it treats. All the Rules are stated in simple language, and each is followed by an example worked out at length and minutely explained. A great number and variety of practical Exercises are given, which, with a carefully framed series of Miscellaneous Questions, place before the Student transactions in real life, and give a freshness and interest to a study that is too frequently rendered repulsive by dry details of abstract matter.

From time to time various improvements have been made on Mr Melrose's original plan, all tending to increase the value of the work as a Class-book; and to add still further to its usefulness, Tables and Exercises on the Metric System are given in this Edition. These will be found amply sufficient for grounding Pupils in the principles of that system, and demonstrating the advantages to be gained by its practical development.

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Product is the sum or result of the operation in Multiplication.

Factors. The multiplicand and multiplier are called *factors* of the product.

Divisor in Division is the number by which we divide.

Dividend ...... is the number to be divided.

Quotient ...... is the number which shows how often the divisor is contained in the dividend, or the result of the operation.

Denomination in applicate numbers is the name of the subject to which the number is applied; as, pounds, shillings, yards, miles, etc.

Numerator is the upper number of a fraction, and shows how many parts of unity are expressed by the fraction.

Denominator is the under number of a fraction, and shows into how many parts the unit is divided.

A **common measure** is any number that will divide two or more numbers without a remainder, and their *greatest common measure* is the greatest number that will do so; thus 2 is a common measure of 12 and 18, and 6 is their greatest common measure.

Multiple. One number is said to be a *multiple* of another when the former contains the latter an exact number of times; thus 8 is a multiple of 4, for 8 contains 4 exactly twice.

A **common multiple** of two or more numbers is any number that contains each of them an exact number of times, and the least number that will do so is called their *least common multiple;* thus 48 is a common multiple of 12, 6, and 4, and 12 is their least common multiple.

= (*equal to*)	denotes	*equality;*	thus 21s.=1 guinea.
+ (*plus*)	......	*addition;*	thus 6+4=10.
— (*minus*)	......	*subtraction;*	thus 7—3= 4.
× (*multiplied by*)	......	*multiplication;*	thus 4×3=12.
÷ (*divided by*)	......	*division;*	thus 18÷6= 3.

: (*is to*) :: (*as*) are signs used in *proportion* to denote an *equality of ratios;* thus 4 : 6 :: 8 : 12 denote that the *ratio* of 8 to 12 is the same as that of 4 to 6, and is read, 4 is to 6 as 8 is to 12.

$\frac{1}{4}$ represents a *farthing*, or the *quarter* of any thing.
$\frac{1}{2}$ .... a *halfpenny* or the *half* of any thing.
$\frac{3}{4}$ .... *three farthings*, or *three quarters* of any thing.

ARITHMETICAL TABLES.

ADDITION AND SUBTRACTION TABLE.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Note. Before commencing Arithmetic it is absolutely necessary that the pupil should commit to memory that part of the preceding table which is cut off by a double line. The remaining part should likewise be learned as soon as possible. The same remark applies to the Multiplication and Division Table on the next page, as well as to all the tables which follow.

MULTIPLICATION AND DIVISION TABLE.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
6	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
7	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
8	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
9	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
10	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
11	11	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220
12	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
13	13	26	39	52	65	78	91	104	117	130	143	156	169	182	195	208	221	234	247	260
14	14	28	42	56	70	84	98	112	126	140	154	168	182	196	210	224	238	252	266	280
15	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300
16	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
17	17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340
18	18	36	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360
19	19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380
20	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

NOTE. In using the preceding Table for a Division one, we take the numbers in the left-hand column out of the numbers in the same horizontal line, and the number of times each is contained l be found either in the top or bottom line.

MONEY TABLE.

			Weight.	
			dwt.	*grs.*
4 farthings, *q.*	= 1 penny, marked	*d.*		
12 pence	= 1 shilling, silver,	*s.*	3	$15\frac{3}{11}$
5 shillings	= 1 crown,	*cr.*	18	$4\frac{4}{11}$
20 shillings	= 1 pound or sovereign, gold,	£	5	$3\frac{3}{11}$

The following coins, though now obsolete, are frequently mentioned:—a guinea, 21s.; a dollar, 4s. 6d.; a moidore, 27s.; a joannes, 36s.; a merk, 13s. 4d.; a Scotch pound was one-twelfth of a pound, or 20 peuce; an Irish pound was twelve-thirteenths of a pound, or 13 pence Irish were equal to 12 pence sterling. The coins of foreign nations are reckoned bullion, and are bought and sold according to their weight and fineness.

A pound troy of sterling silver contains 11 ounces, 2 dwts. of pure silver, and 18 dwts. of pure copper, and is coined into 66 shillings. A pound troy of sterling gold contains 11 ounces of pure gold and 1 ounce of alloy, which is composed of equal parts of pure silver and copper, and is coined into 46·725 sovereigns.

TROY OR GOLD AND SILVER WEIGHT.

24 grains, *gr.*	= 1 pennyweight, marked	*dwt.*
20 pennyweights	= 1 ounce,	*oz.*
12 ounces, or 5760 grains	= 1 pound,	℔.

This weight is used for weighing gold, silver, jewels, etc. Any quantity of gold is supposed to be divided into 24 equal parts, called *carats*. When the whole is pure, it is said to be 24 carats fine; when 23 grains are pure and one is alloy, it is said to be 23 carats fine, and so on. Until 1854 the standards for gold wares were 22 carats and 18 carats; jewellery, etc., is now stamped, of 15, 12, and 9 carats. The diamond carat = 3·168 troy grains; the pearl grain = four-fifths of a troy grain.

APOTHECARIES' WEIGHT.*

20 grains	= 1 scruple, marked	℈
3 scruples	= 1 dram,	ʒ
8 drams	= 1 ounce,	℥
12 ounces	= 1 pound,	℔.

This weight is used only for medical prescriptions.

AVOIRDUPOIS OR COMMERCIAL WEIGHT.

16 drams, *dr.*	= 1 ounce, marked	*oz.*
16 ounces	= 1 pound,	℔.
14 pounds	= 1 stone,	*st.*
28 pounds	= 1 quarter,	*qr.*
100 pounds	= 1 cental	
4 qrs. or 112 lbs.	= 1 hundredweight,	*cwt.*
20 hundredweights	= 1 ton,	*T.*

This weight is used for all articles sold by weight, except those mentioned under troy weight. The lb. avoirdupois = 7000 troy grains; hence 144 lbs. avoirdupois = 175 lbs. troy, and 192 oz. avoir. = 175 oz. troy.

---

* In the British Pharmacopœia (1864), the oz. troy of 480 grains has been abolished; while the lb. avoir., of 7000 grains, and the oz. avoir., of 437½ grains, have been adopted.

LINEAL MEASURE.

12	lines	= 1 inch, marked	*in.*
12	inches	= 1 foot,	*ft.*
3	feet	= 1 yard,	*yd.*
5½	yards	= 1 pole,	*po.*
40	poles, or 220 yards	= 1 furlong,	*fur.*
8	furlongs, or 1760 yards,	= 1 mile,	*ml.*

A pendulum vibrating seconds of mean time, in a vacuum at the level of the sea, in the latitude of London, is = 39·1393 inches.

An inch is sometimes divided into 8 and 16, and also into 10 parts; a fathom is 6 feet; a hand is 4 inches; the chain used for measuring land is 66 feet, and is divided into 100 links, each = 7·92 inches.

CLOTH MEASURE.

2¼	inches	= 1 nail, marked	*nl.*
4	nails, or 9 inches	= 1 quarter of a yard,	*qr.*
4	quarters, or 36 inches	= 1 yard,	*yd.*

3 quarters = 1 Flemish ell; 5 quarters = 1 English ell;
6 quarters = 1 French ell; 37 inches = 1 Scotch ell.

GEOGRAPHICAL OR NAUTICAL MEASURE.

6075⅘ feet = 1 nautical mile.
3 such miles = 1 league, marked *leag.*
20 leagues = 1 degree, *deg.* or °
360 degrees = the earth's circumference = 131237280 feet, or 24855½ miles nearly.

SQUARE OR SUPERFICIAL MEASURE.

144	square inches, *s. in.*	= 1 square foot, marked	*s. ft.*
9	square feet	= 1 square yard,	*s. yd.*
30¼	square yards	= 1 square pole or perch,	*s. per.*
40	perches	= 1 rood,	*ro.*
4	roods	= 1 acre,	*ac.*
640	acres	= 1 square mile,	*s. ml.*

36 sq. yds. are a rood of building, and 100 sq. feet are a square of flooring.

10,000 square links make 1 square chain, and 10 square chains, or 100,000 square links, make 1 acre.

CUBIC OR SOLID MEASURE.

1728 cubic inches, *c. in.*	= 1 cubic foot, marked	*c. ft.*
27 cubic feet	= 1 cubic yard,	*c. yd.*
40 cubic feet of rough, or 50 cubic feet of hewn timber	= 1 load,	*lo.*
5 cubic feet	= 1 barrel bulk,	*B. B.*
8 B. B.	= 1 ton measurement.	

MEASURE OF CAPACITY.

					Cubic inches.
5 oz. avoir. of water	=	1 gill, marked	*gi.*	=	8·6648
4 gills	=	1 pint,	*pt.*	=	34·6592
2 pints	=	1 quart,	*qt.*	=	69·3185
4 quarts	=	1 gallon,	*ga.*	=	277·2738
2 gallons	=	1 peck,	*pk.*	=	554·5477
4 pecks	=	1 bushel,	*bu.*	=	2218·1907
8 bushels	=	1 quarter	*qr.*	=	17745·5260

This measure is used both for liquids and dry goods. 100 gallons of this measure are equal to 120 old wine gallons, or to 98·3 ale gallons, or to 108·15 gallons dry measure; and the Winchester bushel is equal to 7·7556 standard gallons, or to ·9694 standard bushels. 5 quarters make a load or wey.

TIME.

60 seconds, *sec.*	=	1 minute, marked	*min.*
60 minutes	=	1 hour,	*ho.*
24 hours	=	1 day,	*da.*
7 days	=	1 week,	*we.*
4 weeks	=	1 common month,	*mo.*
13 common months and 1 day, or 52 weeks and 1 day, or 365 days	=	1 common year	*co. ye.*
365¼ days	=	1 Julian year,	*Ju. ye.*
366 days	=	1 bissextile or leap year.	

The year is also divided into 12 calendar months, viz.:—

January	31 days	May	31 days	September	30 days
February	28 —	June	30 —	October	31 —
March	31 —	July	31 —	November	30 —
April	30 —	August	31 —	December	31 —

The number of days in each month may be easily remembered from the following lines:—

Thirty days have September,
April, June, and November;
All the rest have thirty-one,
Excepting February alone,
Which has but twenty-eight days clear,
And twenty-nine in each leap year.

The true solar or tropical year is 365 days 5 hours 48 minutes 50 seconds, which is 11 minutes 10 seconds less than the Julian year, and this difference makes 3 days 2 hours 26 minutes 40 seconds in 400 years. To regulate this it has been fixed that every fourth year, as 1868, shall be a leap year, but when a number denoting a complete century is not divisible by 4, as the 19th, 21st, etc., such years should not be reckoned leap years.

ANGULAR MEASURE OR DIVISIONS OF THE CIRCLE.

		seconds, marked	″
60 seconds	=	1 minute,	′
60 minutes	=	1 degree,	°
30 degrees	=	1 sign,	*s.*
12 signs	=	1 circle,	*circ.*

YARN MEASURE.

COTTON YARN.			LINEN YARN.		
54 inches	= 1 thread,	*thr.*	90 inches	= 1 thread,	*thr.*
80 threads	= 1 skein,	*sk.*	120 threads	= 1 cut,	*cu.*
7 skeins	= 1 hank,	*ha.*	2 cuts	= 1 heer,	*he.*
18 hanks	= 1 spindle,	*sp.*	24 heers	= 1 spindle,	*sp.*

APOTHECARIES' FLUID MEASURE.*

				Cubic inches.
	1 fluid minim, marked	*min.*	=	0·0036
60 fluid minims	= 1 dram,	*fl. drm.*	=	0·2166
8 drams	= 1 ounce,	*fl. oz.*	=	1·7329
20 ounces	= 1 pint,	O	=	34·6592
8 pints	= 1 gallon,	C	=	277·2738

FLOUR AND BREAD WEIGHT.

A peck-loaf weighs	17 lbs.	6 oz.	avoirdupois
A half-peck loaf,	8 „	11 „	„
A quarter-loaf,	4 „	5½ „	„

A peck of flour ought to weigh 14·44 lbs., or 14½ lbs. very nearly; and the standard bushel 57·76 lbs., or 57¾ lbs. Five bushels make a sack, which ought to weigh 288·8 lbs.

HAY AND STRAW WEIGHT.

36 lbs. avoirdupois	of straw	= 1 truss, marked	*tr.*
56 „ „	of old hay	= 1 truss	
60 „ „	of new hay	= 1 truss	
36 trusses		= 1 load,	*ld.*

The hay of any year is reckoned old after the end of August.

A load of straw is 11 cwt. and 64 lbs.; a load of old hay is 18 cwt., and a load of new hay 19 cwt. 32 lbs.

THE QUARTERLY TERMS.

IN ENGLAND.		IN SCOTLAND.	
Lady-day,	25th March.	Candlemas,	2d February.
Midsummer,	24th June.	Whitsunday,	15th May.
Michaelmas,	29th September.	Lammas,	1st August.
Christmas,	25th December.	Martinmas,	11th November.

MISCELLANEOUS TABLE.

24 sheets	= 1 quire of paper	120 articles	= 1 great hundred
20 quires	= 1 ream	500 bricks	= 1 load
10 reams	= 1 bale	100 lbs. avoir.	= 1 barl. gunpd.
12 articles	= 1 dozen	56 lbs.	= 1 firkin of butter
20 articles	= 1 score	64 lbs.	= 1 firkin of soap
12 dozen	= 1 gross	256 lbs.	= 1 barrel of soap
12 gross	= 1 great gross	19½ cwt.	= 1 fodder of lead

---

* According to the British Pharmacopœia (1864).

ARITHMETIC.

ARITHMETIC is the science of numbers; it explains their properties, and the art of computing by them.

The fundamental Rules are,—Numeration, Notation, Addition, Subtraction, Multiplication, and Division.

All numbers are expressed by the ten following figures:
One, or unit, two, three, four, five, six, seven, eight, nine, cipher.
1 2 3 4 5 6 7 8 9 0
The first nine are called *digits*, or significant figures; the last is also called *zero*, and signifies nothing.

NUMERATION AND NOTATION.

Numeration is the art of reading a number expressed in figures; Notation is the art of writing a number in figures.

A figure placed singly, or on the right-hand of other figures, signifies so many units. In the second place, it represents so many tens; and, in the third place, so many hundreds.

The cipher serves to bring figures to their proper places by supplying vacant places. Thus, 7, seven; 70, seventy; 700, seven hundred; 750, seven hundred and fifty; 704, seven hundred and four.

Read, and write in words the following:

69—78—50—620—834—157—821—618—18—71—34—193—213—641—709—847—114—611—301—503—171—110—314—121—701—777—510—999.

To read a number consisting of more than three places.

RULE. Divide it from the right-hand into periods of three figures, by placing a comma on the left of the first three, a comma on the left of the next three, and so on. Then, beginning at the left-hand, read each period by itself as before, and call the first period *units*, the second *thousands*, the third *millions*, and so on as in the following:—

NUMERATION TABLE.*

4,	321,	987,	654,	321
V. Period.	IV. Period.	III. Period.	II. Period	I. Period.
Trillions,	Billions,	Millions,	Thousands,	Units.

The periods after trillions are quadrillions, quintillions, etc.

Example.—Read the number 72067984.

M. TH. U.

Pointing it thus, 72,067,984, it is read seventy-two millions, sixty-seven thousand, nine hundred and eighty-four.

Write in words, or read, the following:

8346—9038—5109—73642—100000—6754283—67890100—6700007580—48020—789405037—5107403984626—4720985111—70042067—5700670850—1004015020.

To write a number in figures.

Rule. Write a sufficient number of ciphers, and point them, in order to determine their places; then observe what place every figure of the given number should occupy, and erasing the cipher there, place the figure in its stead.

Ex.—Seventy thousand, six hundred and thirty, is written, $\left.\begin{matrix} \\ \end{matrix}\right\}\begin{matrix}00{,}000\\70{,}630\end{matrix}$

Write in figures the following:

Fifty-seven—four hundred and thirty-two—six hundred and seven—seven hundred and ninety—four thousand seven hundred and twenty—fifty-eight thousand and eight—one hundred thousand four hundred and four—seventy millions—three hundred and thirty-three millions four thousand and four—nine billions four thousand.

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* This method of Notation is employed in France, Italy, and various parts of the Continent. It is now introduced into many British works, being much more simple and elegant than the method still common in this country. The latter system consists in dividing the number into periods of six figures each, there being no period of thousands; it will be noticed from the following table that the two systems are alike as far as hundreds of millions.

TH. UN.	TH. UN.	TH. UN.	TH. UN.	TH. UN.
591,679 ;	429,873 ;	462,581 ;	579,687 ;	479,876
Quadrillions.	Trillions.	Billions.	Millions.	Units.
V. Per.	IV. Per	III. Per.	II. Per.	I. Per.

ROMAN NOTATION.

The Romans expressed numbers by the following letters:—
I = 1, V = 5, X = 10, L = 50, C = 100, D or Iↄ = 500, and M or CIↄ = 1000. These were employed in the following way:—

A number, which is the sum of two or more of these, was written by placing the one of greater value towards the left of the other, as VI = 6, XI = 11, LXXX = 80, CCXIII = 213.

A number, which is the difference of two of these, was written by placing the one of greater value towards the right of the other, as IV = 4, IX = 9, XC = 90.

Every ↄ annexed to Iↄ, and every C and ↄ joined to CIↄ increased the value ten times, as Iↄↄ = 5000, CCIↄↄ = 10,000. A line drawn over a letter, increased its value a thousand times, as $\overline{X}$ = 10,000, $\overline{C}$ = 100,000.

Read VII, XII, XVIII, XIX, XL, LX, LXXX, CXIX, DCCC, MDCCCXV, MDCCCXXXII, MDCCCLXV.

Express in Roman characters 6, 14, 49, 68, 294, 1872.

SIMPLE ADDITION

Is the method of finding one number equal to two or more numbers taken together.

The number found is called the Sum, or Amount.

RULE. Write the given numbers below one another, so that *units* may be below *units*, *tens* below *tens*, etc. Draw a line under the last number; add the right-hand column, and if the sum is one figure, write it under that column; but if it consists of more than one figure, write only the right-hand figure under the column, and carry or add the rest to the second column. In the same manner add the other columns, with the carriages to them; and under the left-hand column write the full sum.

PROOF. Repeat the operation, beginning at the top; or add so many of the given numbers, and to the sum add the rest.

Ex.—Add together 871, 256, 29, and 8. ANS. 1164.

Place the numbers as in the margin; adding the right-hand column, 8 and 9 are 17 and 6 are 23 and 1 are 24; write 4 below it and *carry* 2 to the tens column; 2 and 2 are 4 and 5 are 9 and 7 are 16; write 6 below it and *carry* 1 to the third column; 1 and 2 are 3 and 8 are 11; write 11 below it and the answer or sum is 1164.

$$\begin{array}{r} 871 \\ 256 \\ 29 \\ 8 \\ \hline 1164 \end{array}$$

1.	2.	3.	4.	5.	6.	7.	8.
4213	3520	2461	3574	2468	5971	9764	8621
1042	4205	3512	2467	3571	3485	4879	2796
3400	1345	4265	3516	5286	6789	8497	7269
4321	2413	1456	5764	8467	5287	7948	6297
7852	6548	3526	1482	4213	9356	6873	2618

9.	10.	11.	12.	13.
73846	93784	5293750	23798657	69147873734
29873	73948	4856877	58329412	23781094851
48765	37489	8738495	77361648	75849956926
38214	47398	3878964	815677	2577805734
47386	87934	6916387	7891466	8784158854
78738	12345	6859639	714877	73174498937
96786	54321	8749638	89417675	22534567890

14.	15.	16.	17.	18.
78694	34827583	486792836	5196382	85936428
68975	56385517	9563748	9127644	85373948
57986	27590328	6473928	6378948	672457
97675	13207895	107485075	324	91731234
42317	7967450	870302861	4677836	5498
31247	674976	668279	8272491	35396284
71324	72473682	47538234	648900	18769662
3792	74928	267849026	8007119	97894
976	5536	73628874	5962847	786257

19.	20.	21.	22.	23.	24.
5678	2222	8628475	42734	347636	68004
1234	1111	4683790	2768	67193648	759100
9012	3333	5493652	47385	749462	664850
3456	4444	7849367	7698	9854	947528
7890	5555	8423916	97354	67890	9680823
1234	6666	7854916	21847	729368	1357902
5678	7777	6839462	89673	5267936	96684729
9012	8888	9502121	29	17736824	63877594
3456	9999	1234567	473	90572575	25959470
7890	5060	8991855	8764	7897382	44121066

1. 4529375+9625440+7492736+4261674+19384525.
2. 25832941+78069552+65108344+89318575.
3. 27584995692+83429702756+164835258478.

4. 17248669+69363633+7894+371867+85465884+28746.

5. 4676075+91483+768748+4783827+457202536+84869.

6. 1006158+78024865+6714690+7891236+6978901.

7. 3640615+906232+5378975+345678914+8456789.

8. 91063453+49789141+436789+221459+769123689.

9. 1020256629+8798750+85367847+8734978748+3742988+78963874+87891468+93417348+89148638.

10. 71504814548+38987491689+47467679271+711056387482+714168748799486+1469148754+8911167896.

11. 895970615861+309142866780+811469976+4711438+3714728416+7135891434557+914638+614169416944.

12. 989518521304+378884609183+8901434560+17141687689+714160714896+87145670126486+7890113456+789884469+7861023456+8948704687158+9141687489+714896784359+1141687177+7149168748.

13. A owes B £8967, C £7456, D £7498, E £7538, F £78568, G £91034, and H £9168; required A's debt.

14. A gentleman planted 7846 elms, 7384 ashes, 7889 firs, 718 oaks, 389 birches, and 898 beeches; how many trees did he plant in all?

15. D borrowed of C at one time £348, at another £754, at another £137 and £785; how much did he borrow in all?

16. D paid C at one time £934, at another £121, at another £515, and owes him still £454; what was D's debt originally?

17. The Income of the United Kingdom during one year was, from Customs, £24034000; Excise, £17155000; Stamps, £8994000; Land and Assessed Taxes, £3150000; Property Tax, £10567000; Post-Office, £3650000; Crown Lands, £300000; Miscellaneous, £2753560; what was the gross Income of the United Kingdom for that year?

18. From the creation to the departure from Egypt was 2513 years; thence to the building of Solomon's Temple 487; to the first olympiad 228; to the Jewish captivity 170; to their return 70; to the beginning of the Peloponnesian war 105; to Alexander's conquest of Persia 98; to the first Punic war 69; to the destruction of Carthage 118; to the Christian era 146; to the present year 1864; required the time from the creation.

19. A farmer laid out on oxen £296, on horses £413, on sheep £754, on cows £217, on timber £87, on iron £23, on labouring utensils £173, on household expenses £33; required his total disbursements.

20. Received from A seven hundred and sixty-four pounds, from B one thousand, from C fifty-five, from D eight hundred and one, from E one thousand and sixty-eight, from F eleven thousand eleven hundred and eleven, from G ten thousand one hundred and nine, from H five hundred and sixty pounds; how much did I receive in all?

21. A gentleman left to his widow £4756; to each of his three sons £5785; to his eldest daughter £3756; to each of his other two daughters £2982; to his servants £575; and £984 in other legacies; what did he die possessed of?

22. The number of Post-Office money orders issued in England and Wales during one year was 6444531, in Scotland during the same year there were issued 608597, and in Ireland 533917; how many in that year were issued in the United Kingdom?

23. An army consisted of 8 battalions of foot, and 4 squadrons of horse: A's battalion consisted of 740 men, B's 564, C's 498, D's 722, E's 826, F's 679, G's 734, and H's 504: P's squadron was 294 horse, Q's 245, R's 236, and S's 325; how many horse and foot were in the army?

SIMPLE SUBTRACTION

Is the method of taking a less number from a greater.

The greater number is called the Minuend; the less, the Subtrahend; and the result, the Difference or Remainder.

Rule. Place the less number below the other, as in Simple Addition, and draw a line under it.

Take the right-hand figure of the lower number from that of the upper, if it be less than the upper, and place the remainder under it; if the under figure be the greater, take it from *ten*, and to the remainder *add* the upper figure: in this case *one* must be *carried* to the under figure of the next column before subtracting it.

Proof. The sum of the Subtrahend and Remainder will be equal to the Minuend, if the work is right.

Ex.—From 7485962 take 6798471. ANS. 687491.

From 7485962
Take 6798471
Diff. 687491
Proof 7485962

1 from 2 leaves 1, write 1 below; 7 from 6 we cannot, but 7 from 10 leaves 3 and 6 are 9, write 9 below; having borrowed *ten*, *carry one* to 4 is 5 from 9 leaves 4, write 4 below; 8 from 5 we cannot, but 8 from 10 leaves 2 and 5 are 7, write 7 below; carry *one* to 9 is 10 from 8 we cannot, but 10 from 10 leaves 0 and 8 are 8, &c.

1.*	2.	3.	4.	5.	6.	7.
From 7418	5021	6213	1234	2100	10507	93721
Take 3604	3845	5742	748	1638	9508	45982

8.	9.	10.	11.	12.
123456	957321	50587500	258329412	275849956926
78907	786182	45293750	234530755	206702083192

13.	14.	15.	16.	17.
1005793	2000521	213207895	1870302861	48272491
9897	14675	178380312	1383510025	43076109

18.	19.	20.	21.	22.
10203040	10000000	318769662	69502121	190572575
1020305	1234567	232833234	60873646	190224939

23.	24.	25.	26.	27.
6004002	90807060	244121066	244973386	467607538
506083	9080705	244053062	172486693	462931463

28.	29.	30.	31.	32.
35687214	96721891	100615850	364061525	910634531
27898724	5862994	99609692	360420910	819571078

33.	34.	35.	36.
47054084	70048271	10202566290	715048145489126
39684798	79852	9182309661	714976640674578

37.	38.	39.
1000057321	8959706158610	98951852130430
79632	8063735542749	97962333609126

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* More exercises may be taken from the first two lines of the exercises in Simple Addition.

1. A borrowed from B £6548, of which he has since paid £1874; how much is A still due?

2. A was born in 1825, and died in 1864; how old was he?

3. B was 45 years old in 1861; when was he born?

4. A owes B £8118, but has paid £789; what is due?

5. A gentleman has of yearly rent £3113, and pays £219 of taxes; what is his net income?

6. A man was born in 1824, and his wife in 1841; what is the difference of their ages?

7. A person owes to A £437, to B £981, to C £988, and to D £754; he has in cash £899, and in bills £1000; how much more will he require to pay off his debts?

8. A building was founded in 1519, another 604 years sooner; how long is it since each of these events?

9. The Israelites departed from Egypt anno mundi 2513, and Solomon's Temple was built a. m. 3000; how many years elapsed between these events?

10. A bankrupt owed to A £436, and compounded with him for £177; to B £893, but compounded with him for £379; to C £1114, but compounded with him for £539; to D £1000, but compounded with him for £467; required the bankrupt's total deficiency.

11. X borrowed £1781, and paid £987; borrowed £1114, paid £873; borrowed £891, and paid at two different times £198 each; how much does he still owe?

12. What is the difference betwixt one billion and 197848615?

13. An army, which consisted of 5267 foot and 1100 horse, lost in battle 928 foot and 230 horse, by sickness 456 foot and 212 horse, and by desertion 248 foot and 96 horse; how many remained?

14. Mount Vesuvius is 3932 feet above the sea; how much higher is Mount Etna, whose height is 10874 feet?

15. The sum of two numbers is 98605796, and one of them is 79638978; what is the other?

16. A piece of cloth contains 1235 yards; 247 yards were sold to one person, 349 yards to another, and 199 yards to a third: how much of it was left?

17. The distance of Mercury from the sun is 36793000 miles; how much farther from the sun is Neptune, whose distance is 2854938000 miles?

18. How many years have elapsed since the invention of gunpowder in the year 1302?

19. How long is it since the discovery of the art of printing in 1449?

20. The Duke of Wellington died in 1852, at the age of 83 years; in what year was he born?

21. Sir Isaac Newton was born in 1642; how many years is it since?

22. How long is it since the foundation of the University of Cambridge in 643?

SIMPLE MULTIPLICATION

Is the method of finding the amount of a number, when added as many times as there are units in another number.

The two numbers are called Factors; the first the Multiplicand, the other the Multiplier; and the result the Product.

Case I. When the multiplier consists of one or more figures.

Rule. Place the multiplier under the multiplicand, and draw a line below it as in Simple Addition.

Multiply the right-hand figure of the multiplicand by that of the multiplier, and place the right-hand figure of the product below, and carry the rest to the next product; multiply in like manner every figure of the multiplicand by this figure of the multiplier for the result,—when the multiplier consists of one figure.

If the multiplier consists of more figures,—multiply in the same way by each of them, taking care to place the right-hand figure of each of the products directly under the figure of the multiplier which produces it; the sum of the results thus obtained is the product.

Note. To multiply by 10, 100, 1000, etc., annex the ciphers to the multiplicand; also, when ciphers are annexed to either or both factors, multiply by the significant figures, and annex the ciphers to the product.

Proof. Reverse the factors, and repeat the operation: the product should be the same as before. Or, add together the figures in each factor, casting out the nines as they arise, and multiply the remainders together; the excess of nines in this product should be equal to the excess of the nines in the product.

Ex.—Multiply 54876 by 8. Ans. 439008.

8 times 6 are 48, write 8 below and *carry* 4; 8 times 7 are 56 and 4 are 60, write 0 below and *carry* 6; 8 times 8 are 64, and 6 are 70, etc.

Multiplicand, 54876
Multiplier, 8
Product, 439008

67890314286759 × 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.

Ex. 1. 467298×963
963
1401894 = 3 times.
2803788 = 60 „
4205682 = 900 „
450007974 = 963 times.

Ex. 2. 437520×2030400
2030400
175008
131256
87504
888340608000 product.

1. 78460839 × 23
2. 809875465 × 34
3. 687496 × 46
4. 914749 × 58
5. 709635 × 69
6. 787496 × 47
7. 5789690 × 59
8. 9694098 × 68
9. 678457 × 74
10. 345678 × 85
11. 8912085 × 97
12. 697485 × 100
13. 6789456 × 407
14. 91468379 × 809
15. 831097854 × 8934
16. 574673889 × 5148
17. 7896384 × 305
18. 6849645 × 704
19. 56789015 × 7895
20. 4839786 × 6005
21. 7376870 × 9764
22. 84684689 × 6785
23. 9487096 × 7089
24. 6945873 × 9807
25. 78596439 × 93875
26. 7894683 × 57864
27. 7146874 × 76948
28. 6846000 × 478400
29. 7469400 × 6914000
30. 6785946 × 567890
31. 7146087 × 7080040
32. 879146 × 370854
33. 896385 × 66874
34. 378569 × 700000
35. 3486000 × 850000
36. 7146874 × 8191467

Case II. When the multiplier is the product of two or more factors, none of which exceeds 12.

Rule. Multiply successively by these factors.

Ex.—Multiply 75632 by 45. Ans. 3403440.

75632 × 45 = 9 × 5
9
680688 prod. by 9
5
3403440 prod. by 45

Ex.
Multiply 756821 by 40
40
Product, 30272840

1. 7849687×18
2. 679148×24
3. 919078×33
4. 871498×55
5. 378548×14
6. 919068×45
7. 748969×84
8. 487496×16
9. 678912×50
10. 786241×49
11. 972856×81
12. 456789×28
13. 987654× 64
14. 357428× 48
15. 9146374× 72
16. 8098345×108
17. 6786348×112
18. 9687685×168

1. A field contained 645 shocks of 12 sheaves each; required the number of sheaves.

2. How many letters are in a page containing 45 lines, and each line 59 letters?

3. Ninety-six persons have a legacy divided among them, and the share of each is £354; what was the legacy?

4. I receive £36 per week; what is my yearly income?

5. A gentleman gave his daughter an escritoire, in which was 12 drawers, each having six divisions, and in each division £134; what was the lady's fortune?

6. In a room 16 feet long and 14 feet broad; how many square feet are there?

7. How many stones, each a foot square, will lay a footpath 2640 feet long, and 7 feet broad?

8. How many grains of wheat will fill 987 bushels, when one bushel contains 675000 grains?

9. How many strokes does the hammer of a clock strike in a year of 365 days, at 156 strokes a-day?

10. How many square yards are there in a road 10560 yards long, and 3 yards broad?

11. How many passengers are in 14 trains, each having 9 carriages, and each carriage containing 21 passengers?

12. How many miles will a man walk in 56 years, supposing him to travel 6 miles a-day, and that every year consists of 365 days?

13. How many soldiers are in 15 regiments of 12 companies each, and each company containing 85 men?

14. Sound travels at the rate of 1142 feet per second; how far will it travel in 56 seconds?

15. How many minutes are there in a year?

16. A ship sails 195 miles daily; how far will it sail during a voyage which lasts 93 days?

17. How many letters are in a work consisting of 23 volumes, each of which contains 560 pages, each page 42 lines, and each line 46 letters?

SIMPLE DIVISION

Is the method of finding how often one number is contained in another.

The first number is called the Divisor, the second the Dividend, and the result the Quotient.

CASE I. When the divisor is any number.

RULE. Draw a curve on each side of the dividend, and place the divisor on the left of it.

Point off the least number of figures from the left of the dividend, that will contain the divisor;, find how many times they contain it, and place the number in the quotient on the right of the dividend. Multiply the divisor by the figure placed in the quotient, subtract the product from the pointed off figures, and to the remainder annex the next figure of the dividend. Divide the number thus obtained in the same manner, and so on till all the figures of the dividend are used.

NOTE 1. If a product exceeds the number from which it is to be subtracted, the figure placed in the quotient is too great; and if the remainder is not less than the divisor, the figure in the quotient is too small; in such cases another figure less or greater must be taken.

NOTE 2. To determine the figure to be placed in the quotient, take the first figure of the divisor out of the first or first two of the dividend, and to the remainder annex the next figure of the dividend; if this number does not contain the second figure of the divisor as often as the first was contained, the quotient figure must be lessened, and the work repeated till this takes place.

NOTE 3. To divide by 10, 100, 1000, etc., cut off as many figures from the right of the dividend as there are ciphers.

NOTE 4. When there are ciphers annexed to the divisor, cut them off, and as many figures from the right of the dividend, divide by the other figures, and to the last remainder annex the figures cut off from the dividend.

PROOF. Multiply the quotient by the divisor, and to the product add the remainder; or add the remainder, and all the partial products retaining the places which they occupy in the operation; the sum in both cases should be the dividend. Or subtract the remainder from the dividend, and divide by the quotient; the result should be the divisor.

Ex.—Divide 17092 by 23. **Ans.** $743\frac{3}{23}$.

23 is not contained in 17; pointing off *three* figures, 2 is contained in 17 eight times, but allowing for the carriage (from 3 on the right of 2), 7 is placed in the quotient; 23 × 7 = 161, and 161 being subtracted from 170, 9 remains, to which 9 is annexed, then 2 in 9 is 4, place 4 after 8 in the quotient, etc.

Divisor.	Dividend.	Quotient.
23)	17092	($743\frac{3}{23}$
23 × 7 =	161	23
	99	2229
23 × 4 =	92	1486
	72	3 rem.
23 × 3 =	69	17092 proof.
Rem.	3	

1. 107615827 ÷ 23
2. 8416836 ÷ 17
3. 8916084 ÷ 26
4. 3609198594 ÷ 46
5. 477826524 ÷ 59
6. 6768701338 ÷ 74
7. 4550728662 ÷ 58
8. 67849168 ÷ 79
9. 7774859645 ÷ 85
10. 349168748 ÷ 89
11. 8872486889 ÷ 97
12. 9055424763 ÷ 99
13. 74869435 ÷ 98
14. 5502669904 ÷ 809
15. 417095810538224 ÷ 456
16. 2070784080 ÷ 305
17. 72168551428 ÷ 897
18. 117594325 ÷ 475
19. 218860161 ÷ 689
20. 10140103590 ÷ 3746
21. 839106396 ÷ 5682
22. 3478100289 ÷ 47269
23. 6349154 ÷ 3709
24. 15678421 ÷ 8778
25. 78419678 ÷ 87146
26. 318998232168 ÷ 417396
27. 15359274703104 ÷ 2719064
28. 9774800000 ÷ 67800
29. 1171454353000 ÷ 97000
30. 12709830000 ÷ 8700
31. 68092800000 ÷ 24600
32. 43521606407307 ÷ 10746047
33. 16657947422305625 ÷ [804700625

Case II. When the divisor does not exceed 12.

Rule. Perform the operation by multiplying and subtracting mentally, and write only the quotient below the dividend.

Ex.—Divide 478567 ÷ 6. **Ans.** $79761\frac{1}{6}$.

6 is contained in 47, 7 times and 5 over; in 58, 9 and 4 over; in 45, 7 and 3 over; in 36, 6; and in 7, 1 and 1 over.

6)478567
$79761\frac{1}{6}$ Quot.

Case III. When the divisor is the product of two or more factors, not exceeding 12.

Rule. Divide successively by the factors as in Case II.

Note. To find the true remainder, multiply the first divisor by the remainder of the second division, and to the product add the first remainder; add this sum to the product of the third remainder by the first and second divisors, and so on.

Ex.—Divide 875673 by 42. Ans. $20849\frac{15}{42}$.

$6)\overline{875673} \div 42 = 6 \times 7$
$7)\overline{145945}$—3, quot. by 6
$\overline{20849}$—2, quot. by 42
$(2 \times 6) + 3 = 15$ rem.

Ex. $784652 \div 60$
$6{,}0)\overline{78465{,}2} \div 60$
$13077\frac{32}{60}$ Quot.

1. 7839150462 ÷ 2, 4, 6, 8, 10, 12, 3, 5, 7, 9, 11.
2. 6842753980 ÷ 2, 4, 6, 8, 12, 11, 9, 7, 5, 3, 10.

3. 85536 ÷ 48
4. 149364 ÷ 72
5. 28552 ÷ 144
6. 495368 ÷ 28
7. 29304 ÷ 64
8. 835362 ÷ 81

9. 6908352 ÷ 88
10. 97994448 ÷ 108
11. 470867628 ÷ 121
12. 747781056 ÷ 99
13. 56497608 ÷ 72
14. 2489765 ÷ 16

15. 4879652 ÷ 24
16. 976854 ÷ 49
17. 768945 ÷ 81
18. 6842738 ÷ 154
19. 8423786 ÷ 343
20. 10655400 ÷ 168

1. Divide a tax of £5340 equally among 12 counties.

2. The number of letters in a quarto volume which contained 4465 letters in a page, was 3393400; how many pages were in it?

3. A plantation containing 10656 trees consisted of 96 rows; how many were in each row?

4. My income is £788 per annum; what is it per week?

5. The sum of £4824 is to be raised from 12 counties, in each of which are six parishes; how much must be levied from each parish?

6. The area of a room 18 feet broad is 360 feet; required its length.

7. Twenty-one casks contain 10941 herrings; how many are there in each cask?

8. A multiplier is 789, and the product 6678885; required the multiplicand.

9. How many miles is a person living in Edinburgh carried eastward in an hour in consequence of the earth's diurnal revolution, supposing it performed in 24 hours, and that the parallel of Edinburgh is 13990 miles?

10. How often can 753 be subtracted from 508275?

SUPPLEMENT TO MULTIPLICATION AND DIVISION.

Case I. When the multiplier contains a fraction.

Rule. Multiply by the upper figure of the fraction, and divide the product by the under figure for the fractional product; then multiply by the integer, and add this product to that of the fraction.

Note. For $\frac{3}{4}$ take $\frac{1}{2}$, and $\frac{1}{2}$ of that half; for $\frac{3}{8}$ take $\frac{1}{4}$, and $\frac{1}{2}$ of that fourth, and for $\frac{5}{8}$ take $\frac{1}{2}$, and $\frac{1}{4}$ of that half.

Ex.—Multiply 47843 by $5\frac{2}{3}$. Ans. $271110\frac{1}{3}$.

$$\begin{array}{rll} 47843 & & \\ 5 & & \\ \hline 239215 & = 5 & \text{times} \\ 31895\frac{1}{3} & = \frac{2}{3} & \text{time} \\ \hline 271110\frac{1}{3} & = 5\frac{2}{3} & \text{times} \end{array} \qquad \text{Also,} \quad \begin{array}{r} 47843 \\ 2 \\ \hline 3)95686 \\ \hline 31895\frac{1}{3} \end{array}$$

1. $8426 \times 4\frac{1}{2}$
2. $7938 \times 6\frac{1}{3}$
3. $678 \times 9\frac{3}{4}$
4. $897 \times 7\frac{2}{3}$
5. $627 \times 5\frac{1}{5}$
6. $983 \times 4\frac{1}{6}$
7. $749 \times 9\frac{5}{8}$
8. $837 \times 14\frac{5}{6}$
9. $952 \times 19\frac{3}{8}$
10. $764 \times 12\frac{5}{9}$
11. $683 \times \frac{1}{11}$
12. $964 \times 10\frac{5}{12}$
13. $7682352 \times 113\frac{7}{15}$
14. $6897235 \times 47\frac{5}{23}$
15. $2579368 \times 97\frac{16}{31}$
16. $4785652 \times 197\frac{6}{35}$

Case II. When the divisor contains a fraction.

Rule. Multiply both the divisor and the dividend by the under figure of the fraction, adding the upper figure to the product of the divisor; then divide.

Ex.—Divide 4785239 by $6\frac{2}{3}$ Ans. $717785\frac{17}{20}$.

$$\begin{array}{lrl} 6\frac{2}{3}\,) & 4785239 & \\ 3 & 3 & \\ \hline 2{,}0) & 1435571{,}7 & = \text{prod. by } 3. \\ \hline & 717785\frac{17}{20} & = \text{quotient by } 6\frac{2}{3}. \end{array}$$

1. $738472 \div 4\frac{1}{2}$
2. $689438 \div 8\frac{1}{4}$
3. $946825 \div 6\frac{1}{3}$
4. $92746 \div 7\frac{3}{4}$
5. $6789 \div 10\frac{4}{5}$
6. $857943 \div 11\frac{3}{8}$
7. $829642 \div 23\frac{3}{7}$
8. $897538 \div 365\frac{1}{4}$
9. $678932 \div 29\frac{3}{8}$
10. $7682394 \div 17\frac{3}{16}$
11. $4792654 \div 41\frac{5}{21}$
12. $6543219 \div 13\frac{17}{47}$

CONTRACTIONS IN SIMPLE MULTIPLICATION.

1. *To multiply by* 5. Annex a cipher to the multiplicand and divide by two.

2. *To multiply by* 15. Proceed in the same way, then add the quotient to the dividend.

3. *To multiply by* 25. Annex two ciphers to the multiplicand, and divide by four.

4. *To multiply by* 75. Proceed in the same way, then subtract the quotient from the dividend.

1. 36482 × 5
2. 47935 × 50
3. 67839 × 500
4. 62743 × 15
5. 67938 × 150
6. 49276 × 1500
7. 7386 × 25
8. 9472 × 250
9. 6794 × 75
10. 397 × 75
11. 827 × 1500
12. 974 × 75000

5. *To multiply by any number between* 10 *and* 20. Multiply by the units, and take in the figure on the left.

6. *To multiply by any number between* 100 *and* 110. Mult. by the units, and take in the second figure on the left.

7. *To multiply by any number between* 110 *and* 120. Mult. by the units, and take in the two figures on the left.

13. 7584 × 13
14. 8573 × 17
15. 4978 × 19
16. 5496 × 104
17. 3752 × 106
18. 4286 × 115
19. 7927 × 119
20. 6375 × 112
21. 7493 × 107
22. 6538 × 14
23. 6974 × 117
24. 498 × 118

8. *To multiply by a number consisting entirely of units.* Add together as many figures of the multiplicand as there are units, as in the preceding.

9. *To multiply by a number consisting of the same figure.* Multiply the product for as many units by that figure.

10. *To multiply by a number of nines.* Annex as many ciphers to the multiplicand, then subtract the multiplicand.

25. 6753 × 1111
26. 7589 × 11111
27. 857 × 333
28. 764 × 77
29. 8564 × 888
30. 374 × 99
31. 97 × 999
32. 7564 × 444
33. 397 × 9999
34. 28 × 99999
35. 675 × 7777
36. 5673 × 9998

11. *After finding a line of the product,* other lines may be found by adding or subtracting the multiplicand, or by multiplying the line found; thus, to multiply by 78,—multiply by 7,—and for the product by 8, add the line found to the multiplicand: to multiply by 287,—mult. by 7, and the product by 4 for the sum of the other two lines.

37. 270482 × 36189
38. 978 × 4567
39. 6473 × 72364
40. 578 × 96328
41. 753 × 54279
42. 543 × 56497
43. 6742 × 8927
44. 952 × 7648
45. 9481 × 1728

CONTRACTIONS IN SIMPLE DIVISION.

1. *To divide by 5.* Multiply by 2, and divide by 10. In every case in which the unit's place is 5, the operation may be shortened by multiplying both divisor and dividend by 2, 4, 8, etc., and then dividing the products.

1. 378235 ÷ 5
2. 749382 ÷ 15
3. 4729864 ÷ 25
4. 5836142 ÷ 35
5. 4738472 ÷ 55
6. 6794800 ÷ 125
7. 374964 ÷ 75
8. 496827 ÷ 625
9. 749386 ÷ 45
10. 946782 ÷ 250
11. 784396 ÷ 135
12. 493842 ÷ 750

2. *To shorten the operation.* Divide the divisor and dividend by any number which divides both without a remainder; thus, to divide 864276 by 287,—divide both by 7, and they become 123468 by 41.

13. 483723 ÷ 126
14. 54723 ÷ 87
15. 75424 ÷ 416

3. *To divide by a number consisting of nines.* From the right of the dividend point off as many figures as there are nines, then place the figures not cut off below it, cutting off and placing in the same manner, till all the figures are cut off; then add: the figures cut off form the remainder, and those not cut off the quotient.

16. 739428647 ÷ 999
17. 6539482 ÷ 9999
18. 7538324616 ÷ 99999

4. *To contract the operation.* Subtract the figures of the product as they arise in multiplying, and write down the remainder only.

5. *To render the operation easy.* Make a table of the divisor multiplied by the nine digits, by which means the figure to be put in the quotient, and the product to be subtracted, are seen by inspection.

19. 5716428 ÷ 648
20. 29137064 ÷ 5137
21. 4962840 ÷ 3475
22. 5947382 ÷ 6789
23. 285614 ÷ 8153
24. 571428 ÷ 7916

COMPOUND NUMBERS.

REDUCTION

Is the method of reducing a number from one denomination into another, without altering its value.

Case I. To reduce a higher to a lower name.

Rule. Multiply the highest name given by the number of the next lower contained in it, and to the product add the number of this name; proceed in the same way to the next lower name, and so on to the name required.

Case II. To reduce a lower to a higher name.

Rule. Divide by the number of the given name contained in the next higher, and so on to the name required. —The remainders are of the same name as the dividends.

Proof. In either case, reverse the operation.

Ex. Red. £43, 17s. 9½d. to farth.	Ex. Red. 42134 farth. to £.
Mult. by 20 and add 17s.	4)42134 Farthings.
877 Shillings.	12)10533½ Pence.
Mult. by 12 and add 9d.	2,0) 87,7s. 9½d.
10533 Pence.	£43, 17s. 9½d.
Mult. by 4 and add 2 farth.	
42134 farthings.	

REDUCTION OF MONEY.

1. In 4678567 pounds; how many shil. pen. and farth.?
2. In 47864 guineas; how many shil. pence, and farth.?
3. In 7846 crowns; how many sixpences and threepences?
4. In 87496 pounds; how many crowns and sixpences?
5. In £67, 18s. 10¾d.; how many farthings?
6. In 17s. 0½d.; how many halfpence and farthings?
7. In 78468 guineas; how many shil. fourp. and twop.?
8. In 8416 half-guineas; how many sixpences and halfp.?
9. In 4746 florins; how many shillings and farthings?
10. In 7849 florins; how many shillings, pence, and halfp.?
11. In 78496 pounds; how many shillings and halfpence?
12. In £6784, 18s. 11½d.; how many halfpence and farth.?

1. In 4491424320 farthings; how many pence, shillings, and pounds?
2. In 48246912 farth.; how many pen. shil. and guineas?
3. In 156920 threepences; how many sixp. and crowns?
4. In 3499840 sixp.; how many crowns and pounds?
5. In 65227 farth.; how many pence, shil. and pounds?
6. In 409 halfpence; how many pence, shil. and pounds?
7. In 9886968 twopences; how many fourpences, shillings, and guineas?
8. In 2120832 halfpence; how many pence, sixpences, and half-guineas?
9. In 455616 farthings; how many pence and florins?
10. In 376752 halfpence; how many threepences, shillings, and florins?
11. In 37678080 halfpence; how many pence, shillings, and pounds?
12. In 6513550 farthings; how many halfpence, pence, shillings, and pounds?

Case III. When one of the denominations is not contained exactly in the other.

Rule. Reduce the given number to a name which is contained exactly in that required; then reduce this to the required name.

Ex. Reduce 756 guineas to crowns. **Ans.** 3175 cr. 1s.

756 guin. × 21 = 15876s., and 15876s. ÷ 5 = 3175 cr. 1s.

1. In 84620 guineas; how many crowns and pounds?
2. In £78914; how many crowns, shillings, and guineas?
3. In 914684 half-crowns; how many sixpences, shillings, and florins?
4. In 9146783 half-guineas; how many sixp. and florins?
5. In 714680 guineas; how many pounds and crowns?
6. In 87416835 florins; how many crowns and fourp.?
7. In 73156780 crowns; how many guineas and pounds?
8. In 41146788 fourp.; how many shil. and half-guin.?
9. In £43500; how many shillings, crowns, and pence?
10. In 4200 crowns; how many guineas, shil. and fourp
11. In 42 guin. 17s. 8d.; how many fourp. and hf.-crow

12. In 7465 half-crowns; how many pounds and guineas?
13. In 628238 half-sovereigns; how many guineas?
14. In 46784966 pounds; how many half-guineas?
15. In 726572648 half-guineas; how many pounds?
16. In 526446 pounds; how many dollars, each 4s. 2d.?
17. In 339249 dollars of 4s. 2d.; how many pounds?
18. In 4526457 florins; how many pounds and hf.-guin.?
19. In 7487 guineas; how many crowns and twopences?
20. In 6784 pounds; how many crowns, half-crowns, and sixpences, and of each an equal number?
21. In 63498 half-guineas; how many crowns?
22. In 896328 half-guineas; how many florins?
23. In 57385 crowns; how many half-crowns and guin.?
24. In three purses, each 71 guineas; how many crowns?
25. In £1152; how many crowns, shillings, sixpences, and twopences, and of each an equal number?

REDUCTION OF WEIGHTS AND MEASURES.

1. In 1 ton; how many cwt. qrs. lb. oz. drs.?
2. In 56 tons, 17 cwt. 3 qrs. 14 lb. 11 oz. 13 drs.; how many drams?
3. In 34 cwt. 3 lb. 13 drams; how many drams?
4. In 3 qrs. 14 lb.; how many ounces?
5. In 27 lb. 10 drs.; how many drams?
6. In 14 tons, 15 oz.; how many ounces?
7. In 674968749 oz.; how many lb. qrs. cwt. tons?
8. In 914674 drs.; how many oz., lb. qrs. cwt.?
9. In 896784 drs.; how many oz. lb. cwt.?
10. In 98968 oz.; how many lb. qrs.?
11. In 478698 drs.; how many oz. lb.?
12. In 91474684 oz.; how many tons?
13. In 1 lb.; how many oz. dwt. grs. troy?
14. In 484 lb. 11 oz. 17 dwts. 23 grs.; how many grs.?
15. In 974 lb. 13 dwts.; how many grains?
16. In 11 oz. 21 grs.; how many grains?
17. In 7 lb. 8 oz.; how many ounces?
18. In 15 lb. 3 dwts.; how many grains?
19. In 46080 dwts.; how many oz. lb.?
20. In 78968 grains; how many dwts. oz. lb.?
21. In 4919187 grains; how many dwts. oz. lb.?

22. In 487496 grains; how many oz.?
23. In 74916874 ounces; how many lb.?
24. In 39168744 grains; how many lb.?
25. In 1 pound; how many oz. drs. scr. and grains?
26. In 689 lb. 17 grs.; how many grains?
27. In 784 lb. 4 oz.; how many scruples?
28. In 786496 scruples; how many lb.?
29. In 3741935 grains; how many lb.?
30. In 9146874 drams; how many lb.?
31. In 7487 yards, 3 quarters; how many nails?
32. In 49010 yards, 2 quarters; how many inches?
33. In 4 yds., 2 quarters, 3 nails; how many half-nails?
34. In 784680 nails; how many yards?
35. In 1764378 inches; how many yards?
36. In 9416874 half-nails; how many quarters?
37. In 78467 English ells; how many yards?
38. In 74875 Flemish ells; how many English ells?
39. In 79684 Flemish ells; how many yards?
40. In 914635 yards; how many English ells?
41. In 8768949 French ells; how many Flemish ells?
42. In 7469455 yds.; how many English and French ells?
43. In 3 miles; how many fur. po. yds. ft. in. and lines?
44. In 78916480496 miles; how many yards?
45. In 11 miles, 6 furlongs, 7 inches; how many lines?
46. In 1330467780 inches; how many miles?
47. In 78914638914 yards; how many miles?
48. In 30874968744 inches; how many miles?
49. In 4678 acres; how many roods and perches?
50. In 578 ac. 2 ro. 17 per.; how many perches?
51. In 784 acres, 8 perches; how many yards?
52. In 478 acres, 3 roods, 18 perches; how many perches?
53. In 478964800 perches; how many acres?
54. In 987468946 perches; how many roods?
55. In 4874168498 sq. yards; how many roods?
56. In 4891467896 sq. feet; how many acres?
57. In 294 square yards; how many feet and inches?
58. In 326592 square inches; how many feet and yards?
59. In 38 square yards, 64 inches; how many inches?
60. In 98624 square inches; how many square feet?
61. In 243 cubic yards; how many feet and inches?
62. In 13856832 cubic inches; how many feet and yards?

63. In 4786798948069 cubic inches; how many imperial gallons?—Multiply by 1000, and divide by 277274.
64. How many pints in 8 qr. 3 bu. 2 pk. 1 gal. 2 qt. 1 pt.?
65. How many quarts in 17 qrs. 5 bu. 3 pks.?
66. In 748786 pints; how many quarters, etc.?
67. In 549735 quarts; how many quarters, etc.?
68. In 7 cir. 45 m. 38 sec.; how many seconds?
69. In 375807 seconds; how many signs, etc.?
70. How many seconds in 16 signs 10° 53″?
71. How many seconds in 22 signs 19° 31′ 47″?
72. How many cubic yards in 748693 cubic inches?
73. In 73 cubic yards 7 cubic feet 1035 cubic inches; how many inches?
74. In 64238500 imperial gallons; how many cubic in.?—Multiply by 277274, and divide by 1000.
75. In 784 quarters, 3 pecks; how many gallons?
76. In 200710 gallons; how many quarters?
77. In 4783 qrs. 7 bush. 3 pks. 1 gal. 3 qts. 1 pint; how many pints?
78. In 878468 pints; how many quarters?
79. In 1 ye. 11 mo. 29 da. 23 ho. 59 sec.; how many sec.?
80. In a Julian year; how many hours?
81. In a solar year; how many thirds?
82. In a year, or 365 days, 6 hours; how many seconds?
83. In 11360497554 thirds; how many years?
84. How many seconds have elapsed since the commencement of the Christian era?
85. How long would a person take to count one thousand millions of sovereigns, at the rate of 100 in a minute?
86. If a cannon ball fly uniformly at the rate of 1000 feet in a second; in what time would it reach from the earth to the sun, the distance being 91718000 miles?
87. Reduce the tables placed at the beginning of this book into triangular tables.

NOTE. The work may occasionally be abridged by adding or subtracting a part of the given number, thus:—

To reduce 720 guineas to pounds; add $\frac{1}{20}$.
" 964 English ells to yards; add $\frac{1}{4}$.
" 6768 Scotch ells to yards; add $\frac{1}{33}$.
" 840 pounds to guineas; subtract $\frac{1}{21}$.
" 765 yards to English ells; subtract $\frac{1}{5}$.

COMPOUND ADDITION.

Rule. Write the numbers to be added so that those of the same name may be below each other. Add the numbers in the lowest name, and divide the sum by the number of this name, that makes one of the next higher, then write the remainder, if any, below the column, and *carry* the number of times to the next name; proceed in the same way with the other names to the highest, which is added as in Simple Addition.

Proof. The result may be checked as in Simple Addition.

The sum of the qrs. is 13 = 3¼d., write ¼ below and *carry* 3 to the pence: the sum of the pence is 56 = 4s. 8d., write 8d. below and *carry* 4 to the sh.: the sum of the units column of the sh. is 33, write 3s. below and *carry* 3 to the *tens* of the sh.; the sum is 7 ten-sh. pieces = £3 and 1 ten-sh. piece, place 1 before 3s. and carry 3 to the £'s: the sum of the £'s is £555, and the whole sum £555, 13s. 8¼d.

Example.

£21	17s.	6¼d.
12	4	9½
141	12	11¾
120	16	8½
249	1	10½
9	19	9¾
£555	13s.	8¼d.

Note. In carrying at 12, or at a multiple of 10, the carriage may be found mentally.

1.			2.			3.			4.		
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
58	17	6	135	16	7¼	456	17	6½	739	11	8¼
85	12	9	153	6	11¾	465	12	10¼	793	17	11½
63	15	10	315	14	8½	564	7	5¾	973	15	10¾
36	1	4	351	11	10¾	546	19	2	937	13	5½
98	12	11	513	19	9¼	654	10	11½	379	4	3¾

5.			6.			7.			8.		
9	8	10	8	17	5	94	15	5¾	816	17	8½
8	16	11	5	8	6¼	87	16	6½	389	18	10¼
7	8	3	7	4	4½	91	17	7½	31	17	11
8	16	2	0	19	4¾	67	18	8¾	346	18	6½
7	3	4	18	10	11	84	19	9½	407	13	8¾
8	17	2	3	7	4	98	0	0¾	748	11	11
3	8	11	5	12	7¾	56	17	11	567	14	4¾
6	9	2	8	19	2	133	3	10¼	687	15	10¼
3	7	5	7	2	4	212	18	9	827	16	10¾

9. £17846, 17s. 8d.+£3479, 13s. 11d.+£6783, 14s. 5d. + £687, 15s. 10d. + £8412, 11s. 4d. + £6791, 15s. 7d. + £6149, 17s. 8d. + £8416, 11s. 3d. + £879, 18s. 4d. + £7358, 13s. 8d.+ £3587, 15s. 10d.

10. £4738, 17s. 2d.+£3947, 19s. 8d.+£7135, 13s. 0d.+ £914, 0s. 8d.+£4783, 15s. 11d.+£7198, 17s. 0d.+£8359, 11s. 8d.+£8746, 0s. 0d.+£879, 8s. 7d.+£9157, 16s. 8d.

11. £3109, 0s. 11d.+£798, 13s. 4½d.+£9146, 13s. 7d.+ £874, 0s. 8d.+£9146, 3s. 4d.+£8749, 13s. 5d.+£8735, 19s. 9d.+£9146, 17s. 8d.+£874, 13s. 4½d.+£68, 10s. 4¾d.

12. £7148, 11s. 8½d.+£3596, 18s. 11¼d.+£71416, 13s. 8½d.+£81, 11s. 4d.+£7186, 13s. 4¾d.+£714, 13s. 8¾d.+ £8196, 18s. 10½d.+£811, 8s. 6d.

13. £9148, 11s. 9¼d. + £4937, 10s. 10¾d. + £8719, 11s. 10½d. + £786, 11s. 4¾d. + £91687, 15s. 9½d. + £87146, 11s. 10½d. + £6948, 0s. 8¼d. + £91468, 19s. 0½d. + £9143, 15s. 8¼d. + £10729, 16s. 10¾d.

14. £87191, 11s. 7½d. + £81963, 15s. 7¾d. + £81648, 19s. 9½d.+£7146, 13s. 4½d.+£9146, 17s. 8½d.+£9146, 17s. 4½d. + £87146, 17s. 11¼d. + £9146, 11s. 11d. + £871416, 13s. 9½d. + £708090, 4s. 11¼d.

15.

ton.	cwt.	qr.
43	18	1
31	15	3
71	16	2
52	17	1
7	13	3
6	14	3
8	15	3
59	16	1
23	10	2

16.

lb.	oz.	dr.
23	15	13
21	14	15
8	0	13
15	13	0
6	11	0
7	8	7
8	7	10
24	15	11
17	14	10

17.

cwt.	qr.	lb.	oz.	dr.
56	3	26	14	14
11	2	27	15	13
3	1	18	13	12
16	1	21	10	11
82	2	24	11	15
6	3	25	12	11
4	3	21	13	12
9	2	17	14	13
75	3	23	15	14

18.

lb.	oz.	dwt.	gr.
58	11	15	18
46	8	17	17
8	7	18	15
4	4	19	18
77	5	16	21
6	7	13	23
84	8	12	22

19.

lb.	oz.	dwt.	gr.
11	3	17	11
5	11	15	15
16	5	16	18
17	10	17	21
18	8	18	23
19	0	19	11
15	11	19	10

20.

lb.	oz.	dr.	sc.	gr.
4	11	7	2	11
3	5	1	1	19
7	0	4	2	4
8	0	3	2	0
9	6	0	0	1
8	10	0	1	3
7	2	5	1	2

21.

yd.	qr.	nl.
8	3	1
5	1	2
13	0	1
5	0	3
6	2	2
7	2	2

22.

le.	ml.	fu.	po.
4	2	7	19
4	1	3	27
8	1	4	35
7	2	5	39
4	1	6	18
7	2	7	17

23.

po.	yd.	ft.	in.
15	4	2	11
13	5	0	3
14	3	0	4
18	2	2	9
25	5	0	8
29	4	1	11

24.

ac.	ro.	per.
18	3	18
15	1	39
16	2	38
18	0	28
24	3	27
25	3	19

25.

ac.	ro.	per.	yd.
7	1	18	15
5	3	19	29
8	0	17	18
18	0	38	28
3	3	39	4
4	2	15	7

26.

qr.	bu.	pk.
14	1	3
13	7	1
14	3	2
13	4	2
11	5	0
12	6	3

27.

pk.	ga.	qt.
3	1	2
5	1	3
2	0	1
6	1	2
7	0	3

28.

bu.	pk.	ga.	qt.
74	1	1	3
85	3	0	2
64	2	1	1
68	3	1	2
70	2	0	3

29.

qr.	bu.	pk.
61	3	2
54	7	3
59	6	1
63	5	3
68	7	3

30.

s.	°	′	″
21	15	27	48
14	27	50	27
18	29	59	59
20	16	25	39
11	21	48	35

31.

ho.	m.	s.
39	40	54
25	38	49
29	46	54
33	51	43
38	54	19
46	56	39
56	19	27

32.

da.	h.	m.
243	18	40
198	23	59
214	13	41
34	0	22
29	21	0
41	19	17
139	7	38

33.

co. y.	da.	ho.	m.
472	135	19	56
527	351	23	39
325	326	21	48
475	237	19	57
648	219	17	53
596	228	15	49
749	364	23	59

34.

Ju. y.	da.	ho.
54	219	23
75	327	10
83	345	12
78	239	16
65	189	19
69	298	18
45	177	22

35. A owes to B £475, 18s. 11d., to C £748, 18s. 9½d., to D £37, 19s. 8¾d., to E £974, 19s. 0½d., to F £14, 6s. 0¾d., to G £18, 0s. 11d., to H £1984, 17s. 0d., and to K £15, 0s. 6½d.; required A's debt.

36. I have in cash £148, 17s. 8d., wine valued at £718, 11s. 8d., rum £398, 18s. 5½d., brandy £178, 19s. 11d., gin £918, 13s. 11d., tea £518, 11s. 11d., sugar £315, 19s. 8½d., other goods £317, 19s. 8d.; required my stock.

37. A merchant has in his shop 314 yds. 3 qrs. 2 nls. of blue cloth, 204 yds. 3 nls. of black, 654 yds. 2 qrs. 3 nls. of brown, 71 yds. 1 qr. 2 nls. of scarlets, 854 yds. of mixtures, and 763 yds. 3 nls. of various other colours; how much has he in all?

38. A housekeeper went to market and laid out on tea £2, 4s. 8½d., on coffee £1, 5s. 8¾d., on sugar £3, 17s., on beef £1, 7s., on mutton 36s., on veal 7s., and on various other articles 29s.; how much was laid out in all?

39. A bankrupt owed to A £784, 18s. 11½d., to B £315, 17s. 8d., to C £88, 0s. 11¾d., to D £778, 15s. 8d., to E £785, 17s. 11½d., to F £13, 8s. 6½d., to G £57, 18s., to H £318, and to I £154, 0s. 11d.; required his whole debt.

40. J carried to market £437, 18s. 10d., and received there from A £54, 8s. 8d., from B £78, 13s. 9d., from C £34, 8s., from D £87, 8s. 10d., from E £54, from F 18s., 10½d., from G 13s. 11¾d., and from H £15, 18s. 0¾d.; how much had J in all?

41. A collector drew in January £67, 18s. 8d., February £63, 14s. 9d., March £94, 18s., April £93, 19s., May £108, 17s. 11d., June £118, 13s. 6½d., July £99, 13s. 6¾d., August £73, 19s. 9¾d., September £53, 15s. 9d., October £68, 0s. 11d., November £48, 18s. 10d., December £73, 11s. 8d.; how much did he collect in the year?

42. A merchant has in cash £99, 8s. 6d., doeskin valued at £342, 18s., tweeds £224, 14s. 8d., braids £13, 7s. 8½d., linings £18, 17s. 11¼d., flannels £12, 11s. 7¼d., thread £2, 6s. 9½d., buckram £4, 19s. 11½d., hose £17, 18s. 9d., stockings £18, 17s. 8d., hats £21, 19s. 6d., house and shop £221; also, A owes him, per bond, £888, B £756, C £374, M, per account, £23, 18s. 11d., N £14, 18s. 6d., P £56, 19s. 5d., Q £73, 14s. 9d., R £13, 18s., S 17s. 8½d., T £1, 6s. 8¾d., W 19s. 11¾d., X 13s. 4d., Y 15s. 8d., Z £18, 14s. 10d.; required his stock.

43. Required the amount of the following sums, due by a certain bank, viz., to A £687, 17s. 11½d., B £677, 18s. 10½d., C £345, 14s. 9¾d., D £789, 15s. 8d., E £467, 16s. 7½d., F £912, 17s. 4d., G £456, 18s. 6½d., H £891, 19s. 8¼d., K £345, 10s. 7¼d., L £789, 18s. 4d., M £234, 14s. 9¼d., N £678, 15s. 6d., O £123, 16s. 4¾d., P £567, 7s. 8d., and to Q £912, 18s. 9¾d.

44. The produce of a sugar plantation for 16 years was as follows:—1st year 687 cwt. 3 qr. 27 lb. 15 oz. 14 dr.; 2d, 958 cwt. 1 qr. 26 lb. 13 oz. 15 dr.; 3d, 436 cwt. 2 qr. 24 lb. 14 oz. 13 dr.; 4th, 891 cwt. 1 qr. 25 lb. 13 oz. 15 dr.; 5th, 648 cwt. 3 qr. 27 lb. 13 oz. 14 dr.; 6th, 168 cwt. 1 qr. 23 lb. 14 oz. 13 dr.; 7th, 734 cwt. 2 qr. 2 lb. 15 oz. 14 dr.; 8th, 687 cwt. 2 qr. 22 lb. 13 oz. 13 dr.; 9th, 434 cwt. 2 qr. 23 lb. 10 oz. 13 dr.; 10th, 578 cwt. 3 qr. 19 lb. 11 oz. 15 dr.; 11th, 916 cwt. 1 qr. 18 lb. 12 oz. 14 dr.; 12th, 876 cwt. 1 qr. 14 lb. 13 oz. 12 dr.; 13th, 914 cwt. 3 qr. 15 lb. 14 oz. 14 dr.; 14th, 768 cwt. 1 qr. 16 lb. 15 oz. 13 dr.; 15th, 696 cwt. 3 qr. 13 lb. 14 oz.; 16th, 768 cwt. 1 qr. 14 lb. 14 oz. 14 dr.; required the total produce.

45. Paid for ground to build a house £250, mason's bill £424, 17s. 6d., carpenter's £621, 15s. 9d., slater's £210 13s. 4d., smith's £17, 18s. 9d., glazier's £74, 18s. 11d.; at what should it be sold to gain £150?

46. A gentleman has of silver plate, viz. spoons, weight, 11 lb. 11 oz. 19 dwt. 22 gr., teapots 3 lb. 9 oz. 17 dwt. 19 gr., knives and forks 5 lb. 10 oz. 15 dwt., salts 3 lb. 17 dwt. 13 gr., salvers 11 lb. 11 oz. 23 gr., tankards 11 lb. 11 oz. 19 dwt. 22 gr., vases 28 lb. 3 oz. 17 dwt. 15 gr.; required the total weight of his plate.

47. Required the contents of a gentleman's estate, consisting of the following farms, viz., 1st, 467 acres, 3 roods, 18 per.; 2d, 678 ac. 2 ro. 27 per.; 3d, 876 ac. 3 ro. 37 per.; 4th, 678 ac. 3 ro. 39 per.; 5th, 326 ac. 1 ro. 33 per.; 6th, 146 ac. 3 ro. 34 per.; 7th, 47 ac. 1 ro. 21 per.; 8th, 89 ac. 2 ro. 34 per.; 9th, 17 ac. 1 ro. 31 per.; 10th, 147 ac. 3 ro. 15 per.; 11th, 134 ac. 2 ro. 37 per.; 12th, 108 ac. 2 ro. 4 per.

48. A contributed £27, 15s. 6½d. to a charity, B £5, 7s. 6d. more than A, C £6, 17s. 8½d. more than A and B together, D contributed £35, 9s. 8¼d., E £2, 8s. 6d. more than D, and F £5, 14s. 8½d. more than D and E together; how much did they contribute in all?

49. A gentleman left to his widow £6874, 19s. 6½d.; to each of his three sons, £4799, 18s. 7¼d.; to each of his four danghters, £3597, 2s. 3¾d.; and to charities, £3675, 11s. 11¼d.: how much did he leave in all?

COMPOUND SUBTRACTION.

Rule. Write the less number below the greater, so that names of the same kind may be below each other. Subtract the lowest name in the under line from that in the upper, and write the remainder below it; but if the under number be greater than the upper, subtract it from the number of this name which makes one of the next higher, and to the remainder add the upper number; then write the sum below, and carry *one* to the under number of the next name: proceed in the same way to the highest name.

Proof. The same as in Simple Subtraction.

Ex.—From £215, 12s. 3½d. take £97, 18s. 9¾d. Ans. £117, 13s. 5¾d.

3f. from 2f. we cannot, but 3f. from 4f. (= 1d.) is 1f. and 2f. are 3f.; write 3f. below, and *carry* 1d. to 9d. is 10d. from 3d. we cannot, but 10d. from 12d. (= 1s.) is 2d. and 3d. are 5d.; write 5d. below and *carry* 1s. to 18s. is 19s. from 12s. we cannot, but 19s. from 20s. (= £1) is 1s. and 12s. are 13s.; write 13s. below, and *carry* £1 to £97 is £98 and £98 from £215 are £117; write £117 below, and the remainder is £117, 13s. 5¾d.

From	£215	12s.	3½d.
Take	97	18	9¾
Diff.	£117	13s.	5¾d.

1.

£	s.	d.
60	8	9
50	19	11

2.

£	s.	d.
58	19	9¼
50	2	4¼

3.

£	s.	d.
715	10	0
620	14	6¼

4.

3997	8	11
3180	11	2½

5.

66807	9	8
48960	12	0

6.

55862	0	4
51123	3	2

7.

50650	6	5¾
47541	5	6¾

8.

99153	10	2¼
92004	18	5¾

9.

309987	9	0¼
300838	17	3

10.

£	s.	d.
1243954	19	2
1156763	7	6½

11.

cwt.	qr.	lb.	oz.	dr.
192	3	17	12	5
135	3	18	13	7

12.

yd.	qr.	n.
55	2	2
46	3	1

13.

lb.	oz.	dwt.	gr.
293	5	7	4
234	5	11	10

14.

lb.	oz.	dr.	sc.	gr.
49	0	7	2	0
44	0	7	2	9

15.

qr.	bu.	pk.	ga.	pt.
32	1	2	1	5
23	5	3	1	6

16.

ml.	fu.	po.	yd.	ft.	in.
131	4	8	3	2	10
116	4	13	3½	2	11

17.

ac.	ro.	pe.	yd.
48	0	29	10¼
40	3	10	25½

18.

Ju.y.	da.	h.	m.
237	118	13	41
189	223	11	53

19. A merchant has in cash £474, 8s. 9d., goods, £3443, 15s., a house £713, 11s., a ship £574, another £315, debts due to him £957, 18s. 11½d.; and he owes to A £115, 7s. 8d., to B £327, 18s. 4¾d., to C £74, 13s. 4d.; required his net stock.

20. A borrowed from B the following sums, viz., £781; £63, 15s.; £52, 10s.; and £565; and has paid at different times,—in cash, £330, 10s.; £54, 13s. 4d.; £67, 10s.; in goods, £54, 18s. 6d.; £73, 15s. 8d.; and by a draft on John Steele, £63: what is A still due?

21. A bankrupt owed to one of his creditors £678, 18s. 10d., to a second £773, 17s. 6d., to a third £541, 17s. 6½d., a fourth £168, 18s. 8d., a fifth £764, 13s. 4d., a sixth £987, 14s., a seventh £896, 19s., an eighth £871, 17s. 8d., a ninth £173, 17s. 11d., a tenth £999, 15s., an eleventh £479, 16s. 9d. His effects were as follows: Debts due to him by A £217, 8s. 8d., by B £113, 17s. 9d., by C £434, 8s. 9d., by D £454, 16s. 8d., by E £137, 19s. 6d., by F £73, 18s. 10½d., by G £64, 11s. 8d., by H £206, 13s. 11d.; a house £350, two more, each £546, furniture £215, 18s. 11d., cloth £213, 14s. 8d., linen £313, 8s., tea, in three lots, £33, 18s. 10d., £44, 18s. 11d., £96, 17s. 8d., port, 4 hhds. at £19, 13s. each: required a state of his affairs.

22. A merchant has in cash £146, 18s. 11d., in goods, viz., cloth, valued at £212, 14s. 6d., linen £311, 4s., cambrics and lawns £256, 14s. 6d., muslins £217, 19s. 11d., silks £314, 18s., cottons £178, 13s. 8d., stockings £73, 14s. 6d., hats £87, 13s. 11d., gloves £24, 13s. 9d., house and shop £256; A owes him £737, B £113, 8s., and C £56, 13s. 11d. He owes to four wholesale dealers, £156, 10s. 9d., £297, 17s. 11d., £384, 16s. 8d., £21, 17s. 7d., to three manufacturers, £38, 18s. 4d., £47, 15s. 11d., £33, 15s. 5d.; also to

M £13, 6s. 6d., to N £25, 4s. 6d., to P £17, 18s. 10d., to Q £15, 10s., to R £23, 17s. 11d., to S, upon bond, £155. Required his net stock.

23. A goldsmith purchased silver, from A 25 lb. 10 oz. 13 dwt., from B 13 lb. 15 gr., from C 19 lb. 8 oz. 19 dwt. 23 gr., from D 14 lb. 8 dwt. 22 gr., from E 16 lb. 11 oz. 15 gr.; of which he made into teaspoons 31 lb. 18 gr.; knives and forks 21 lb. 10 dwt.; four tea-pots, each 3 lb. 2 oz. 15 dwt. 13 gr.; and sold at three different times 13 lb. 4 oz. 15 dwt., 3 lb. 14 dwt. 22 gr., 8 lb. 16 dwt. 19 gr.: how much has he remaining?

24. A gentleman gave a silversmith 32 lb. of silver to make into knives and forks, weighing 7 lb. 15 dwt., three vases, each 4 lb. 11 oz. 12 gr., spoons 6 lb. 5 oz. 13 dwt. 15 gr., salvers 1 lb. 2 oz. 14 dwt. 18 gr., the rest to be made into a punch-bowl; required its weight.

25. Bought 3 hhds. of sugar, each 4 cwt. 3 qr. 16 lb. which was retailed as follows, viz.: 2 cwt. 13 lb., 1 cwt. 2 qr. 18 lb. 15 dr., 3 cwt. 3 qr. 27 lb. 15 dr., 3 qr. 17 lb. 12 dr., 23 lb. 15 dr., 15 lb. 13 oz. 14 dr., 17 lb. 11 oz. 15 dr., 2 cwt. 16 lb. 11 oz. 12 dr.; how much remained?

26. A trader owed to A £357, 18s. 10½d., of which he has paid £249, 19s. 11¾d.; to B £287, 18s., of which he has paid £198, 19s. 11d.; to C £487, 19s., paid £298, 13s. 8¾d.; to D £78, 17s. 9d., paid £39, 18s. 11½d.; to E £59, 13s. 6d., and paid at three different times, £13, 15s. 6d., £17, 11s. 3d., £19, 8s. 11d.; how much is the trader still due?

27. A gentleman has an estate of 3465 acres; he farms off to A 463 ac. 2 ro. 14 per., B 146 ac. 3 ro. 15 per., C 713 ac. 1 ro. 17 per., D 831 ac. 37 per., E 547 ac. 38 per., F 496 ac. 3 ro. 39 per.; how much has he remaining in his own hand?

28. A wine merchant bought 47 hhds. 17 ga. of wine, and sold 13 hhds. 8 ga. 7 pt.; bought 33 hhds. 38 ga. 5 pt., sold 44 hhds. 47 ga. 3 pt.; bought 54 hhds. 19 ga. 3 pt., sold 45 hhds. 62 ga. 7 pt.; bought 96 hhds. 43 ga. 2 pt., sold 57 hhds. 13 ga. 6 pt.; bought 23 hhds. 57 ga., sold 45 hhds. 12 ga. 4 pt.; bought 91 hhds. 54 ga. 6 pt., sold 34 hhds. 18 ga. 5 pt. (1 hhd. = 63 ga.); required the quantity unsold.

29. A brewer had in his cellar 173 hhds. 17 ga. of beer, of which he sent to six customers, as follows, viz.: 1st, 17 hhds. 15 ga. 5 pt.; 2d, 2 hhds. 53 ga. 7 pt.; 3d, 21 hhds. 13 ga. 4 pt.; 4th, 23 hhds. 14 ga. 3 pt.; 5th, 12 hhds. 18 ga. 3 pt.; 6th, 15 hhds. 51 ga. 7 pt.: at this time he had brought into his cellar 24 hhds. more, and sent to three other of his sustomers 7 hhds. 39 ga. 5 pt. each (1 hhd. = 54 galls.); how much remained in his cellar?

30. A collector of taxes gave receipts to one part of his district for £304, 18s. 8d., to another £256, 13s. 4d., to another £417, 18s. 11¼d., to another £784, 18s., to another £964, 13s. 9d., to another £1000, to another £98, 17s. 10¾d., and to another £294, 18s. 11d. His own salary was £140; he paid three clerks £40, £30, £25, and six sub-collectors, each £35. Find the net revenue.

31. The state of X's debts is as follows:—To A, on bond, £756, 18s. 10d., with interest £42, 18s. 6d., of which he has paid £378, 15s. 10d.; to B £456, 18s. 8d., interest £23, 18s. 4d., paid £208, 14s.; to C £574, 10s. 8d., interest £37, 10s. 10d., paid £318, 17s. 8d.; to D £517, 4s. 6d., paid £113, 11s. 9d.; to E £377, 19s. 11d., interest £17, 19s., paid £137, 10s. 6d.; to F £391, 10s., interest £31, 17s. 10d.; to G £474, 17s. 9½d., interest £94, 7s. 8d., paid £191, 19s. 11d.; to H £577, 11s. 8d., interest £35, 17s. 9½d., paid £398, 17s. 9d.; to K £1000, interest £50, paid £273, 17s.; how much money will pay his debts?

32. Required the net weight of 9 hhds. tobacco, viz., 1st, 8 cwt. 3 qr. 14 lb., tare 3 qr. 17 lb.; 2d, 7 cwt. 2 qr., tare 3 qr. 11 lb.; 3d, 5 cwt. 1 qr. 16 lb., tare 2 qr. 26 lb.; 4th, 9 cwt. 1 qr. 7 lb., tare 3 qr. 27 lb.; 5th, 8 cwt. 1 qr., tare 3 qr. 5 lb.; 6th, 4 cwt. 3 qr., tare 1 qr. 7 lb.; 7th, 6 cwt. 2 qr., tare 2 qr. 27 lb.; 8th, 7 cwt. 3 qr. 18 lb., tare 2 qr. 22 lb.; 9th, 8 cwt. 3 qr. 21 lb., tare 3 qr. 26 lb.

33. Eight hhds. of sugar weigh as follows:—1st, 27 cwt. 3 qr. 14 lb., tare 1 cwt. 13 lb.; 2d, 37 cwt. 27 lb., tare 1 cwt. 3 qr. 8 lb.; 3d, 21 cwt., tare 1 qr. 27 lb.; 4th, 43 cwt., tare 1 cwt. 1 qr. 19 lb.; 5th, 17 cwt. 18 lb., tare 2 qr. 20 lb.; 6th, 19 cwt. 1 qr. 5 lb., tare 26 lb.; 7th, 47 cwt., tare 1 cwt. 3 qr. 25 lb.; 8th, 44 cwt. 2 qr. 17 lb., tare 1 cwt. 17 lb.: required the net weight of each hhd., and the gross, tare, and net weight of the whole

34. A, B, and C, receive £89, 19s. 7½d., now A and B receive £64, 6s. 7¾d., and B and C £55, 10s. 10d.; how much does each receive?

35. What is the difference between 495 guineas and £387, 12s. 8¼d.?

36. From £375, 6s., take 250 gu. 7s. 6¾d.

COMPOUND MULTIPLICATION.

Case I. When the multiplier does not exceed 12.

Rule. Write it under the lowest name of the multiplicand, and in multiplying *carry* as in Compound Addition.

Proof. Multiply separately by two numbers the sum of which is the multiplier, and add the products.

Ex.—Multiply £7, 15s. 4¾d. by 9. Ans. £69, 18s. 6¾d.

£7, 15s. 4¾d.
9
£69, 18s. 6¾d.

9 times 3f. = 27f. or 6¾d.; write 3f. below and *carry* 6d. 9 times 4d. are 36d. and 6d. are 42d. or 3s. 6d.; write 6d. below and *carry* 3s. 9 times 5s. are 45s. and 3s. are 48s.; write 8s. below, and *carry* 4 ten-shilling pieces. 9 times 1 are 9 and 4 are 13 ten-shilling pieces = £6, and 1 ten-shilling piece; place 1 before 8s., making 18s., and *carry* £6. 9 times £7 are £63 and £6 are £69.

	£	s.	d.			£	s.	d.			£	s.	d.	
1.	4	6	7½	×3	7.	13	5	7¼	×10	13.	70	0	11½	×12
2.	9	8	4¼	×4	8.	0	0	4¾	×11	14.	73	0	8	×11
3.	74	18	11½	×6	9.	15	0	7½	× 4	15.	0	19	8	×10
4.	0	17	3¾	×7	10.	17	8	0¾	× 5	16.	54	13	0	× 9
5.	18	0	11	×8	11.	0	9	7½	× 7	17.	73	17	8¾	×11
6.	17	15	0¼	×9	12.	18	0	4¼	×11	18.	57	19	0	×12

19. 7 cwt. 2 qr. 18 lb. × 9
20. 15 lb. 13 oz. 5 dr. ×11
21. 18 lb. 3 oz. 14 dwt. 5 g. ×12
22. 74 lb. 11 oz. 5 dr. 2 sc. ×12
23. 37 ton 15 cwt. 2 qr. × 4
24. 15 lb. 13 oz. 3 dr. × 5
25. 13 lb. 3 oz. 8 dwt. 5 gr. × 6
26. 54 ml. 3 fu. 18 p. 3 yds. × 7
27. 3099 ga. 3 qt. 1 pt. × 8
28. 7 bu. 3 pk. 2 pt. × 3
29. 27 qr. 5 bu. 3 pk. 1 ga. 1 qt. × 8
30. 3 ye. 5 mo. 29 da. × 9
31. 2 da. 3 ho. 59 m. ×10
32. 14 ac. 3 ro. 39 per. × 9
33. 8 ac. 2 ro. 14 per. ×11
34. 365 da. 5 h. 48 m. 57 s. ×12
35. 4554 ga. 3 qt. 1 pt. ×11
36. 2989 ga. 1 qt. 1 pt. ×12
37. 240 per. 16 yd. 4 ft. ×11

Case II. When the multiplier is the product of two or more factors none of which exceeds 12.

Rule. Multiply successively by these factors.

Ex. 1. £6, 13s. 3¾d. × 54 = 6 × 9
6
39 19 10½ = 6 times
9
£359, 18s. 10½d. = 54 times.

da. ho. m.
Ex. 2. 17 15 34 × 72 = 12 × 6
12
211 18 48 = 12 times.
6
1270 16 48 = 72 times.

	£	s.	d.			£	s.	d.			£	s.	d.	
1.	63	0	8¾	×18	7.	23	15	0	×24	13.	15	18	11¼	×16
2.	17	11	8¼	×20	8.	15	0	8	×30	14.	37	7	0	×36
3.	13	17	0½	×36	9.	13	15	11½	×42	15.	7	8	11¾	×88
4.	27	18	0	×45	10.	17	4	0	×48	16.	8	8	0	×108
5.	0	17	11¼	×56	11.	54	13	0¼	×60	17.	19	11	4	×144
6.	0	0	10¾	×72	12.	0	19	11¾	×84	18.	17	5	0	×168

19. 37 cwt. 3 qr. 16 lb. × 15
20. 17 lb. 0 oz. 15 dr. × 24
21. 21 lb. 13 dwt. 17 gr. × 77
22. 56 acres 2 ro. 9 pe. × 28
23. 27 miles 6 fu. 9 po. × 54
24. 37 yd. 2 qr. 3 nl. × 63

Case III. When the multiplier is not the product of two or more factors none of which exceeds 12.

Rule. Multiply by the factors of the nearest composite number, and also by the difference; then add the products when the assumed product is less than the multiplier, otherwise subtract them.

Ex.—£3, 9s. 5¾d. × 58; and 2 ac. 3 ro. 12 per. × 118.

	£	s.	d.
	£3,	9s.	5¾d.
58 = (8×7) + 2			8
8 times =	27	15	10
			7
56 times =	194	10	10
2 times =	6	18	11½
58 times =	£201,	9s.	9½d.

	ac.	ro.	per.
	2	3	12
118 = (12×10) − 2			12
	33	3	24
			10
120 times =	339	0	0
2 times =	5	2	24
118 times =	333	1	16

	£	s.	d.			£	s.	d.			£	s.	d.	
1.	3	7	0¼	×17	6.	77	18	0¼	×59	11.	62	13	8	×58
2.	4	0	3½	×23	7.	63	17	8	×19	12.	18	19	0	×61
3.	7	0	0¾	×41	8.	53	13	8¾	×39	13.	77	13	4	×68
4.	0	7	8¼	×51	9.	0	14	8¼	×47	14.	33	4	6	×74
5.	18	11	4	×53	10.	0	19	4½	×57	15.	14	7	0	×82

16. 17 lb. 4 oz. 17 dwt. 15 gr. × 26
17. 21 cwt. 3 qr. 21 lb. 12 oz. × 37
18. 18 miles, 5 fur. 18 po. 4 yd. × 47
19. 35 yards, 2 qr. 3 nl. 2 in. × 59
20. 44 acres, 3 ro. 35 per. 17 yd. × 71
21. 54 quarters, 5 bu. 3 pk. 1 gal. × 93

Case IV. When the multiplier is large.

Rule. Multiply by 10 *once* less than the number of figures in the multiplier; again multiply the given line by the right-hand figure, the next line by the second figure, and so on; then add the products thus obtained.

Ex.—£2, 12s. 7½d. × 3456. **Ans.** £9093, 12s. 0d.

	£2,	12s.	7½d.	× 6 =	£15,	15s.	9d.	=	6 times
			10						
10 times =	26	6	3	× 5 =	131	11	3	=	50 times
			10						
100 times =	263	2	6	× 4 =	1052	10	0	=	400 times
			10						
1000 times =	2631	5	0	× 3 =	7893	15	0	=	3000 times
					£9093,	12s.	0d.	=	3456 times

Note.—To multiply a name by 10, annex to it the carriage from the lower name, and reduce to the next higher.

	£	s.	d.	
1.	57	18	9½	× 348
2.	99	13	6	× 3469
3.	84	13	9	× 4660
4.	1	15	0½	× 7841
5.	77	11	4¼	× 6352
6.	79	19	8	× 10002
7.	137	18	4½	× 1141
8.	15	18	3	× 673
9.	18	11	11	× 9145
10.	6	7	8	× 632
11.	4	18	9½	× 561
12.	7	11	11¾	× 423

Find the price of

1. 14 cwt. sugar, at £2, 10s. 7½d. per cwt.
2. 7 stones wool, at 18s. 7¾d. per stone.
3. 11 lb. tea, at 13s. 4¾d. per lb.
4. 12 yd. velvet, at 17s. 8½d. per yd.
5. 15 st. sugar, at 9s. 10¾d.
6. 18 st. steel, at 10s. 11¼d.
7. 37 oz. silver, at 5s. 5¼d.
8. 20 cwt. figs, at £1, 4s. 8½d.
9. 24 sets china, at £1, 15s. 4¾d. per set.
10. 27 sheep, at £2, 5s. 9½d.
11. 57 yd. silk, at £1, 7s. 8½d.
12. 32 yd. velvet, at £2, 8s. 9½d. per yard.

13. 51 yd. velvet, at £1, 15s. 9½d. per yard.
14. 35 casks rum, at £2, 17s. 6½d. per cask.
15. 40 do. wine, at £3, 12s. 11¼d. per cask.
16. 76 cwt. lead, at £2, 18s. 9d.
17. 45 cwt. iron, at £1, 4s. 7½d.
18. 60 bales cotton, at £3, 14s. 4¾d. per bale.
19. 65 do. do., at £1, 17s. 6½d.
20. 72 bar. tar, at £2, 15s. 4½d.
21. 82 do. do., at £1, 17s. 5½d.
22. 85 stone steel, at 4s. 9¾d.
23. 35 score lambs, at £8, 15s. 4½d. per score.
24. 52 weeks' work, at 14s. 6½d. per week.
25. 8 yd. cambric, at 9s. 8¼d.
26. 9 yd. cotton, at 11s. 5½d.
27. 42 yd. silk, at £1, 16s. 7½d.
28. 56 yd. lawn, at 14s. 4½d.
29. 40 yd. cloth, at 19s. 4¼d.
30. 99 yd. silk, at 5s. 6d.
31. 42 lb. tea, at 13s. 4½d.
32. 31 hhds. flax, at £3, 4s. 8½d. per hhd.
33. 33 pipes wine, at £12, 8s. 6d. per pipe.
34. 83 pun. rum, at £25, 12s. 8d. per puncheon.
35. 97 yd. muslin, at 4s. 9½d.
36. 21 yd. linen, at 3s. 7d.
37. 77 yd. velvet, at 12s. 0¾d.
38. 73 lb. cloves, at 15s. 6½d.
39. 99 barrels raisins, at £4, 3s. 7½d. per barrel.
40. 75 do. figs, at £1, 19s. 8½d. per barrel.
41. 336 lb. coffee, at 4s. 6d.
42. 87 yd. muslin, at 4s. 9d.
43. 350 yd. ditto, at 7s. 0½d.
44. 89 lb. snuff, at 1s. 6¾d.
45. 450 yd. silk, at £2, 3s. 11¼d. per yard.
46. 95 stones of wool, at 14s. 7d. per stone.
47. 102 ditto, at 33s. 11d.
48. 29 score lambs, at £4, 5s. per score.
49. What is the weight of 47 hhds. tobacco, each 6 cwt. 2 qr. 17 lb. 13 dr.?
50. What is the weight of 98 ingots of silver, each 2 lb. 11 oz. 17 dwt.?
51. What is the weight of 45 pieces of lead, each 3 lb. 7 oz. 14 dwt. 13 gr.?
52. What is the weight of 7 parcels of medicine, each 1 lb. 10 oz. 7 dr. 1 scr. 17 gr.?
53. What is the weight of 486 guineas, each 5 dwt. 9 grs.?
54. What length of road will a man make in 39 days, at 1 po. 5 yd. 2 ft. 4 in. per day?
55. How large is an estate consisting of 9 farms, each 47 ac. 2 ro. 13 pe. 29 yd.?
56. How much flour will a mill grind in 313 days, at 1 qr. 3 bu. 3 pk. per day?

57. What quantity of wine will be consumed in a year, at 1002 gal. 1 qt. 1 pt. per day?
58. What quantity of beer and ale, in the same time, at 25315 gal. 3 qt. 1 pt. per day?
59. How far will a man travel in 43 days, at 37 ml. 5 fu. 18 po. per day?
60. In what time could 9 houses be built, if each, on an average, required 1 ye. 11 mo. 29½ da.?

COMPOUND DIVISION.

Case I. When the divisor is any whole number.

Rule. Divide the highest denomination as in Simple Division, and reduce the remainder into the next lower name, adding the given number of that name; divide this sum in the same manner, and so on until the lowest name is divided.

Proof. The same as the first in Simple Division.

Ex.—£375, 18s. 4½d. ÷ 43. **Ans.** £8, 14s. 10$\frac{0}{4}$d. $\frac{26}{43}$.

	43) £375, 18s. 4½d.	(£8, 14s. 10$\frac{0}{4}$d. × 1
43 × 8 =	344	6
	31 × 20	52 9 0 = 6 times.
	638s.	7
43 × 1 =	43	367 3 0 = 42 times.
	208	8 14 10 = 1 time.
43 × 4 =	172	6½ = rem.
	36 × 12	£375 18s. 4½d. Proof.
	436d.	
43 × 10 =	430	
	6 × 4	
rem.	26f.	

	£	s.	d.			£	s.	d.			£	s.	d.	
1.	18	7	6	÷17	8.	999	18	6	÷69	15.	918	17	5½	÷ 97
2.	27	12	0	÷23	9.	341	16	8½	÷71	16.	1118	13	6	÷ 98
3.	10	8	6½	÷26	10.	488	15	8½	÷74	17.	332	18	2	÷104
4.	17	1	7¾	÷31	11.	500	18	1½	÷78	18.	102	10	6¾	÷109
5.	38	2	4¼	÷43	12.	931	19	9	÷87	19.	207	8	4½	÷231
6.	167	7	7	÷38	13.	478	13	0¾	÷89	20.	9814	10	5	÷758
7.	418	13	4	÷65	14.	118	15	7	÷79	21.	215	12	6¼	÷317

22. 490 lb. 3 oz. 5 dwt. 3 gr. ÷23
23. 1025 yd. 1 ft. 5 in. ÷57
24. 1062 ml. 4 fu. 14 po. ÷61
25. 170 qr. 3 bu. 1 pk. ÷19
26. 249 yd. 2 qr. 3 nl. ÷17
27. 168 ac. 0 ro. 3 per. ÷29
28. 127 qr. 4 bu. 3 pk. ÷37

Case II. When the divisor does not exceed 12.

Rule. Divide and reduce mentally.

Ex.—Divide £27, 14s. 5¾d. by 5. **Ans.** £5, 10s. 10¾d.

5 is contained in £27, 5 times and £2 over; £2 are 40s. and 14s. are 54s.; 5 in 54s. is 10 times and 4s. over; 4s. are 48d. and 5d. are 53d., 5 in 53d. is 10 times and 3d. over; 3d. are 12f. and 3 far. are 15f., 5 in 15f. is 3 times.

		£	s.	d.	
5)		£27,	14s.	5¾d.	
Quot.		£5,	10s.	10¾d.	
Mult. by				5	
Proof,		£27,	14s.	5¾d.	

	£	s.	d.	
1.	57	18	9	÷4
2.	33	17	6	÷6
3.	798	13	4	÷5
4.	87	15	6	÷6
5.	54	15	8	÷7
6.	91	13	8	÷8
7.	899	7	6	÷6
8.	6	1	2¼	÷7
9.	498	17	8	÷8
10.	195	15	2¼	÷9
11.	7	10	4	÷11
12.	73	17	8	÷11
13.	17	1	7	÷12
14.	812	15	0¼	÷11
15.	8	19	0	÷12

16. 118 lb. 8 oz. 7 dwt. ÷ 4
17. 27 lb. 8 oz. 10 dr. ÷ 5
18. 19 lb. 11 oz. 3 dr. 2 sc. ÷10
19. 73 yd. 1 qr. 3 nl. ÷ 5
20. 149 lb. 3 oz. 15 dwt. 22 grs. ÷ 7
21. 107 yd. 2 ft. 6 in. ÷ 6
22. 53 yd. 2 ft. 11 in. ÷ 3
23. 87 ml. 0 fu. 30 po. ÷ 5
24. 176 yd. 1 qr. 0 nl. ÷12
25. 47 qr. 1 bu. 2 pk. ÷ 5
26. 78 qr. 3 bu. 3 pk. ÷ 9
27. 68 cwt. 3 qr. 22 lb. ÷ 9
28. 167 lb. 4 oz. 7 dr. ÷11
29. 74 lb. 11 oz. 6 dr. ÷12
30. 54 ac. 2 ro. 4 per. ÷12
31. 302 to. 4 cwt. 0 qr. ÷ 8
32. 158 lb. 3 oz. 14 dr. ÷10

Case III. When the divisor is the product of two or more factors none of which exceeds 12.

Rule. Divide successively by these factors mentally.

Ex.—Divide £125, 16s. 8d. by 24. **Ans.** £5, 4s. 10¼d. ¹¹⁄₂₄

4)£125, 16s. 8¾d. ÷ 24 = 4 × 6
6) 31, 9 2⁰⁄₄ – 3, quot. by 4
£5, 4s. 10¼d. – 2 „ by 24
(2 × 4) + 3 = 8 + 3 = 11 remainder.

	£	s.	d.			£	s.	d.			£	s.	d.	
1.	7	6	0	÷24	9.	22	6	3	÷90	17.	37	16	0	÷ 21
2.	64	19	0	÷36	10.	37	5	7½	÷30	18.	93	16	10½	÷ 99
3.	37	14	8	÷48	11.	4	4	4½	÷45	19.	75	12	0	÷ 84
4.	380	9	0	÷42	12.	22	1	0	÷56	20.	45	0	0	÷120
5.	78	16	8	÷16	13.	135	0	0	÷50	21.	9	2	0	÷ 96
6.	9134	1	8	÷55	14.	38	8	0	÷36	22.	36	6	0	÷132
7.	529	4	0	÷63	15.	198	8	0	÷64	23.	81	4	0	÷336
8.	56	14	0	÷72	16.	113	8	0	÷72	24.	21	4	8	÷112

25. 104 qr. 2 bu. 3 pk. ÷ 14
26. 447 lb. 7 oz. 13 dwt. 9 gr. ÷ 21
27. 971 yd. 1 ft. 6 in. ÷ 54
28. 975 ml. 3 fu. 24 po. ÷ 56
29. 162 ac. 36 per. ÷ 28

Case IV. When the divisor is compound.

Rule. Reduce both divisor and dividend to the lowest name in either; then divide as in Simple Division.

	£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
1.	301	2	8¼	÷	7	0	0¾	6.	8866	0	0½	÷	1	5	0½
2.	570	1	3	÷	13	11	5½	7.	2855	7	0¾	÷	27	14	5¼
3.	50	6	10	÷	0	17	11¾	8.	4539	8	4	÷	0	18	7¼
4.	905	1	3	÷	8	7	7¼	9.	348	5	5	÷	0	19	1
5.	4349	1	7¼	÷	6	3	8¾	10.	2673	1	6	÷	7	13	7½

1. If 11 yards of cloth cost £4, 5s. 0¼d.; what is the price of 1 yard?
2. A person sold 9 pieces of lawn, each 11 yards, at £38, 5s. 2¼d.; what was the price per yard?
3. If 47 lb. tea cost £34, 10s. 3¾d.; what is it per lb.?
4. If a farm of 57 acres is let at £55, 4s. 4½d.; what is the rent per acre?
5. If 9 hhds. sugar weigh 68 cwt. 3 qrs. 22 lb.; required the weight per hhd.
6. Three men, A, B, C, make an adventure, each equally concerned, whereby they clear £370; what was each man's share of the gain?
7. Seven men are equally concerned in an adventure to Madeira, they lose £878, 3s.; what is the loss of each?
8. Divide £3, 10s. among 5 men and 6 women, and give each man thrice the share of a woman.
9. If 37 yd. cloth cost £23, 13s. 3½d.; what is the price of one yard?

10. If 48 yd. cost £33, 16s. 6d.; what will 8 yd. cost?

11. If 7 casks weigh 1 ton, 3 cwt. 3 qr. 21 lb.; what does one cask weigh?

12. If 28 casks contain 28 bu. 3 ga. 2 qt.; what will 7 casks contain?

13. A piece of cloth at 8s. 4d. per yard cost £18, 15s.; how many yards were in it?

14. A piece of gold cost £161, 17s. 6d., at £4, 7s. 6d. per oz.; what was its weight?

15. A gentleman gave £5, 13s. 4d. among some poor people, giving each 6s. 8d.; how many poor were there?

16. The revenues of a hospital amount to £5629, 10s.; how many patients will it maintain, when each patient requires £8, 13s. 9d.?

17. A log of wood weighs 17 to. 13 cwt.; how much wood is there in it when a solid foot weighs 56 lb.?

18. A servant having contracted a debt of £2, 6s. $8\frac{1}{2}$d., allows $9\frac{1}{2}$d. of his wages to lie in his master's hands every week; in what time will this pay the debt?

19. A labourer's house rent is £3, 13s. 9d. yearly; how much must he lay aside weekly, in order to pay it?

SUPPLEMENT TO COMPOUND MULTIPLICATION AND DIVISION.

When the Multiplier or Divisor contains a fraction, proceed as in the Supplement to Simple Multiplication and Division.

	£	s.	d.				£	s.	d.		
1.	7	3	5	×	$4\frac{1}{2}$	9.	43	17	$5\frac{3}{4}$	÷	$4\frac{1}{3}$
2.	5	14	7	×	$3\frac{1}{4}$	10.	86	18	$10\frac{1}{2}$	÷	$9\frac{3}{5}$
3.	40	7	$6\frac{1}{2}$	×	$7\frac{3}{4}$	11.	74	10	$7\frac{3}{4}$	÷	$8\frac{1}{2}$
4.	36	10	$7\frac{1}{4}$	×	$11\frac{3}{8}$	12.	89	18	$8\frac{1}{2}$	÷	$11\frac{3}{4}$
5.	49	18	8	×	$24\frac{1}{9}$	13.	486	17	$10\frac{3}{4}$	÷	$25\frac{3}{7}$
6.	56	10	$10\frac{1}{2}$	×	$38\frac{3}{5}$	14.	589	19	$11\frac{3}{4}$	÷	$46\frac{3}{5}$
7.	6 cwt. 3 qr. 17 lb.			×	$5\frac{1}{3}$	15.	23 cwt. 3 qr. 18 lb.			÷	$6\frac{4}{7}$
8.	8 qr. 4 bu. 1 p. 1 g. 1 qt.			×	$7\frac{1}{5}$	16.	84 ac. 2 ro. 34 pe.			÷	$14\frac{7}{15}$

QUESTIONS ON THE PRECEDING RULES.

1. What cost $7\frac{1}{4}$ yards cloth, at 13s. 6d. per yard?

2. What cost $9\frac{3}{5}$ gallons, at 19s. $7\frac{1}{2}$d. per gallon?

3. What is the weight of $3\frac{3}{4}$ hhds. of sugar, each 4 cwt. 3 qr. 11 lb.?

4. If 13¾ yd. cloth cost £8, 17s. 7¼d.; what is the price per yard?

5. If 11⅝ cwt. sugar cost £46, 16s. 6d.; what is the value per cwt.?

6. Divide £394, 11s. 7d. among 5 men and a boy, and give the boy ½ of a man's share.

7. How many yards are in 678 poles?

8. How many years of 365¼ days are in 75642 days?

9. How many moons of 29½ days are in 9874 days?

10. How many English ells are in 758 links, each $7\frac{23}{25}$ in.?

11. How many ft. are in 857 Scotch ells, each 37 in.?

12. How many Scotch ells are in 740 English feet?

13. A merchant paid £89, 6s. 5½d. for 5 pieces of cloth, at 14s. 6½d. per yard; how many yards were in a piece?

14. A gentleman's income is £960; what should be his daily expenses to save £150 per annum?

15. A labourer earns 15s. 6d. a-week; how much should he spend in a week to save £9 for his house-rent and clothes?

16. In 48 purses, each containing a florin, a crown, a half-guinea, and a half-crown; how many pounds?

17. In 10602 dollars, each 4s. 3d.; how many pounds?

18. In 5170 pistoles, each 17s. 6d.; how many guineas?

19. In 74867 crowns, how many dollars, each 4s. 6d.?

20. In 678495 Scotch ells, how many yards?

21. How many francs of 9¾d. are in £2717?

22. How many dollars, each 4s. 3d., are in £1312, 3s. 9d.?

23. In £1939, 11s. 8d.; how many florins?

24. A gentleman was robbed of the following sums, viz., 54 pieces of £3, 12s. each, 48 of 36s. each, 234 of 16s. 6d. each, 196 of 27s. each, 215 of 4s. 9d. each, 464 notes of £50 each; required the amount of his loss.

25. How many lb. of silver are in 2 dozen dishes, each dish weighing 25 oz. 15 dwt., and 2 dozen plates, each 15 oz. 15 dwt. 22 gr.?

26. How many hhds. sugar, each 11½ cwt., are in 141680 lb.?

27. How many canisters, each holding 12 lb., can be filled from 25 cwt. 2 qr. 24 lb. of tea?

28. In 1463645556 yards, how many Scotch ells?

29. How many inches will reach round the terrestrial globe, it being 360 degrees, and each degree 69½ miles?

30. How many inches will reach round the moon, its circumference being 6817 ml. 2 fu. 7 po.?

31. In 20790 gallons; how many pipes of 126 galls. each, puncheons of 84 gal., hhds. of 63 gal., and tierces of 42 gal., and of each an equal number?

32. There are 63 stacks of corn, each computed to contain 3 qr. 5 bu. 2 pk.; how much in the whole?

33. Mercury revolves 148 times round the sun in 35 ye. 249 da.; required the time of one revolution.

34. The distance between London and Edinburgh is about 390 miles; how often will a coach-wheel of 15 feet circumference revolve in performing the journey?

35. How many letters are in a book of 12 volumes, each 421 pages, each page 36 lines, and each line 38 letters?

36. Required the net weight of 11 hhds. tobacco, each 6 cwt. 1 qr. 12 lb., tare 1 qr. 14 lb. per hhd.

37. Divide £26, 3s. 11½d. among 4 men, 6 women, and 8 children, giving each man double a woman, and each woman triple a child.

38. The weekly wages of an equal number of men, women, and children, amount to £170, 12s. 6d., now each man receives 25s. 6d. per week, each woman 15s. 6d., and each child 4s. 6d.; how many are there of each?

39. If 6 chests of bohea tea weigh 8 cwt. 1 qr. 18 lb.; what is the weight per chest?

40. A gentleman has 2 dozen table-spoons, each 2 oz. 14 dwt.; 3 dozen tea ditto, each 14½ dwt.; 4 mugs, each 13 oz. 17 dwt.; 2 tankards, each 23 oz. 13 dwt.; required the weight of the whole.

41. If 15 hhds. sugar weigh 52 cwt. 26 lb.; what is the weight of 1 hhd.?

42. What is the net weight of 7 hhds. of sugar, each 3 cwt. 2 qr. 17 lb., tare 18 lb. per hhd.?

43. What is the net weight of 56 hhds., each 3 cwt. 24 lb., tare 16 lb. per hhd.?

44. What is the net weight of 36 hhds., each 8 cwt. 3 qr., tare 18 lb. 2 oz. 12 dr. per hhd.?

45. What is the net weight of 5 hhds., each 6 cwt. 2 qr. 14 lb., tare 3 lb. 4 oz. per hhd.?

46. A merchant paid £89, 6s. 5½d. for 5 pieces of cloth, each 25 yards; at what must he sell it per yard to gain £1, 11s. 3d. on the whole?

47. A merchant paid £64, 18s. for 288 yards of cloth, which getting damaged, he is content to lose £1, 13s. by it; at what must he sell it per yard?

48. A merchant bought 7 pieces of cloth, each 27 yards, for £55, 12s., and sold 56 yards of it at 5s. 3½d. per yard, and the rest at 6s. 8d.; whether did he gain or lose by it, and how much?

49. If a workman gains every week 12s. 6d., and spends 9s. 11¾d.; how much does he lay up in a year?

50. If a man gains 1s. 9d. per day, and spends 13½d.; how much does he lay up in a year?

51. A person's income is 4s. 6d. per day, and his expenses £71, 1s. 6d. yearly; how much does he save, or overspend, yearly, and how much does he spend weekly?

52. If 5 men, equally concerned in an adventure, clear each £114, 18s. 6d.; what was gained upon the whole?

53. Four men have an equal share of a voyage to Jamaica, whereby they lose £348, 15s.; what was the loss of each?

54. What was the stock of that trading company which consisted of 76 shares, each £784, 13s. 6d?

THE GREATEST COMMON MEASURE.

The Greatest Common Measure of two or more numbers is the greatest number which divides each of them exactly.

TO FIND THE G. C. M. OF TWO NUMBERS.

Rule. Divide the greater number by the less, and the divisor by the remainder continually, until there is no remainder; the last divisor is the G. C. M. of the two.

Ex.—Find the G. C. M. of 72 and 126. Ans. 18.

$$\begin{aligned} 54 &= 18 \times 3 \\ 72 = 54 \times 1 + 18 &= 18 \times 4 \\ 126 = 72 \times 1 + 54 &= 18 \times 7 \end{aligned}$$

Hence, since 4 and 7 are prime to each other, 18 is the greatest common divisor of 72 and 126.

```
72)126(1
    72
    ‾‾
    54)72(1
       54
       ‾‾
       18)54(3
          54
          ══
```

Find the G. C. M. of,

1. 304 and 336
2. 165 and 195
3. 357 and 425
4. 2431 and 2717
5. 2160 and 4032
6. 4524 and 5460
7. 13179 and 8977
8. 11760 and 16170
9. 60025 and 34986

NOTE. The G. C. M. of three numbers is obtained by finding that of any two of them, and again the G. C. M. of the result and the remaining number.

THE LEAST COMMON MULTIPLE.

THE Least Common Multiple of several numbers is the least number which contains each of them exactly.

TO FIND THE L. C. M. OF SEVERAL NUMBERS.

RULE. Arrange the numbers after each other in a line; divide by *two* as often as any of the numbers will divide by 2, bringing down those not divisible by 2; in the same way divide by 3, 5, 7, and so on by all the prime numbers; the continued product of the divisors is the L. C. M. of the numbers.

EX.—Find the L. C. M. of 4, 6, 20, 15, and 84. ANS. 420.

$$\begin{aligned}4 &= 2 \times 2\\ 6 &= \phantom{2 \times{}} 2 \times 3\\ 20 &= 2 \times 2 \phantom{{}\times 3} \times 5\\ 15 &= \phantom{2 \times 2 \times{}} 3 \times 5\\ 84 &= 2 \times 2 \times 3 \phantom{{}\times 5} \times 7\end{aligned}$$

Hence, the least number which contains each of the given numbers exactly is 2 × 2, × 3 × 5 × 7 = 420.

2	4,	6,	20,	15,	84
2	2,	3,	10,	15,	42
3	1,	3,	5,	15,	21
5	1,	1,	5,	5,	7
7	1,	1,	1,	1,	7
	1,	1,	1,	1,	1

Find the L. C. M. of,

1. 7, 14, 18, 24.
2. 2, 9, 12, 15, 27.
3. 8, 6, 14, 28, 32.
4. 6, 15, 18, 24, 30.
5. 32, 44, 52, 13, 65, 48.
6. 12, 14, 16, 35, 48, 63.
7. 143, 187, 51, 156, 429.
8. 76, 38, 152, 448, 748.

VULGAR FRACTIONS.

A FRACTION is one or more parts of a thing, and supposes the unit to be divided into a number of equal parts; it is expressed by two numbers, one above the other, with a line between them, as $\frac{1}{3}$, $\frac{3}{5}$, $\frac{4}{12}$.

The under number is called the *denominator*, and shows the number of parts into which the unit is divided; the upper number is called the *numerator*, and shows how many of these parts the fraction contains; the two together are called the terms of the fraction.

$\frac{3}{7}$ may be read $\frac{3}{7}$ of 1 or $\frac{1}{7}$ of 3.

A *proper fraction* is one whose numerator is less than its denominator, as $\frac{3}{7}$.

An *improper fraction* is one whose numerator is equal to or greater than its denominator, as $\frac{5}{5}$, $\frac{8}{5}$.

A compound fraction consists of two or more fractions connected with the word *of*, as $\frac{2}{5}$ of $\frac{3}{5}$.

A mixed number consists of an integer (whole number) and a fraction, as $4\frac{3}{7}$.

An integer has 1 for its denominator, as $4 = \frac{4}{1}$.

The value of a fraction is not altered by multiplying or dividing its terms by the same number. It is multiplied by *multiplying* its numerator or by *dividing* its denominator; and it is divided by *dividing* its numerator or *multiplying* its denominator.

REDUCTION OF VULGAR FRACTIONS.

PROBLEM I. To reduce an improper fraction to a whole or a mixed number.

RULE. Divide the numerator by the denominator; if there is a remainder, place the denominator below it in the form of a fraction, and annex it to the quotient.

EX.—Reduce $\frac{17}{5}$ to a mixed number. ANS. $3\frac{2}{5}$.

$$\text{Here, } \tfrac{17}{5} = 17 \div 5 = 3\tfrac{2}{5}.$$

Reduce to mixed numbers,

$\frac{35}{5}$; $\frac{19}{3}$; $\frac{67}{4}$; $\frac{108}{7}$; $\frac{101}{8}$; $\frac{15}{2}$; $\frac{78}{7}$; $\frac{67}{5}$; $\frac{241}{19}$; $\frac{376}{25}$; and $\frac{4768}{13}$.

PROB. II. To reduce a mixed number to an improper fraction.

RULE. Multiply the integer by the denominator, and add the numerator; under this sum write the denominator.

EX.—Reduce $6\frac{7}{8}$ to an improper fraction. ANS. $\frac{55}{8}$.

$$\text{Here, } 6\tfrac{7}{8} = \frac{(6 \times 8) + 7}{8} = \frac{48 + 7}{8} = \frac{55}{8}.$$

Reduce to improper fractions,

$4\frac{3}{5}$; $6\frac{1}{3}$; $14\frac{1}{4}$; $15\frac{3}{7}$; $12\frac{5}{8}$; $7\frac{1}{2}$; $11\frac{1}{7}$; $13\frac{2}{5}$; $12\frac{13}{19}$; $15\frac{1}{25}$; $366\frac{10}{13}$.

Prob. III. To reduce a compound to a simple fraction.

Rule 1. Multiply all the numerators together for the required numerator, and all the denominators together for the required denominator.

Rule 2. Strike out those factors which are common to the numerators and denominators; then multiply.

Note. First reduce mixed numbers to improper fractions.

Ex.—Reduce $\frac{4}{15}$ of $\frac{5}{16}$ of $\frac{6}{7}$ to a simple fraction. **Ans.** $\frac{1}{14}$.

Here, $\frac{4}{15}$ of $\frac{5}{16}$ of $\frac{6}{7} = \frac{120}{1680}$; or $= \frac{1}{1} \times \frac{1}{2} \times \frac{1}{7} = \frac{1}{14}$.

Reduce to simple fractions,

$\frac{3}{5}$ of $\frac{4}{15}$; $\frac{3}{7}$ of $\frac{5}{8}$ of $\frac{1}{6}$; $\frac{4}{7}$ of $\frac{5}{12}$ of 6; $\frac{3}{5}$ of $\frac{12}{19}$; $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{4}{7}$ of $9\frac{1}{3}$; $\frac{6}{11}$ of $\frac{5}{8}$; $\frac{7}{11}$ of $6\frac{7}{8}$ of $3\frac{1}{5}$; and $\frac{4}{11}$ of $6\frac{2}{7}$ of 14.

Prob. IV. To reduce a fraction to its lowest terms.

Rule 1. Divide both terms by their G. C. M.

Rule 2. Divide the terms successively by all those numbers which measure them.

Note. 2 measures any *even* number; 5 measures any number, ending in 0 or 5; 3 or 9 when the *sum* of the digits composing the number contains either of them exactly; 11 when the *sums* of the *alternate* digits of the number are equal.

Ex.—Reduce $\frac{66}{484}$ to its lowest terms. **Ans.** $\frac{3}{22}$.

Here, $\frac{66}{484} \div \frac{22}{22}$ (G. C. M.) $= \frac{3}{22}$; $\frac{66}{484} \div \frac{11}{11} = \frac{6}{44} \div \frac{2}{2} = \frac{3}{22}$.

Reduce to their lowest terms,

$\frac{176}{484}$; $\frac{48}{160}$; $\frac{7845}{96780}$; $\frac{8664}{8986}$; $\frac{740}{8675}$; $\frac{764}{5240}$; $\frac{644}{1728}$; $\frac{768}{1024}$; $\frac{3360}{4032}$; $\frac{404}{1111}$; $\frac{1022}{1241}$; $\frac{4485}{10335}$; $\frac{1936}{847}$; $\frac{73205}{19965}$; and $\frac{76923}{999999}$.

Prob. V. To reduce fractions to others of equal value having the least common denominator.

Rule. Reduce compound to simple and mixed numbers to improper fractions; find the L. C. M. of the denominators for the required one, then divide it by each of the denominators, and multiply the quotients by the respective numerators for the required numerators.

Note.—The fractions must all be in their lowest terms.

Ex.—Reduce $\frac{12}{27}$, $\frac{6}{11}$ of $\frac{33}{30}$, and $5\frac{1}{7}$ to their least common denominator. **Ans.** $\frac{140}{315}$, $\frac{189}{315}$, $\frac{1620}{315}$.

$$\text{Here, } \frac{4}{9}, \frac{3}{5}, \frac{36}{7} = \frac{35\times4}{315}, \frac{63\times3}{315}, \frac{45\times36}{315} = \frac{140}{315}, \frac{189}{315}, \frac{1620}{315}$$

Reduce to their least common denominator,

1. $\frac{7}{8}$ and $\frac{5}{6}$.
2. $\frac{1}{2}$, $\frac{1}{3}$, $\frac{3}{4}$.
3. $\frac{5}{6}$, $\frac{7}{8}$, $\frac{8}{9}$, $\frac{9}{10}$.
4. $\frac{3}{4}$, $\frac{5}{8}$, $\frac{7}{12}$, $\frac{1}{6}$.
5. $\frac{2}{7}$, $\frac{9}{14}$, $\frac{17}{21}$, $\frac{5}{42}$.
6. $\frac{5}{6}$, $\frac{7}{12}$, $\frac{5}{18}$, $\frac{7}{36}$.
7. $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, $\frac{4}{9}$, $\frac{15}{16}$.
8. $\frac{7}{11}$, $\frac{8}{9}$, $\frac{6}{13}$.
9. $\frac{4}{15}$, $\frac{11}{12}$, $\frac{3}{13}$, $\frac{1}{11}$.
10. $\frac{8}{9}$, $\frac{3}{11}$, $\frac{7}{18}$, $\frac{9}{22}$.
11. $\frac{4}{5}$, $\frac{3}{7}$, $\frac{13}{15}$, $\frac{16}{17}$.
12. $\frac{3}{8}$, $\frac{7}{21}$, $\frac{4}{16}$, $\frac{18}{24}$, $\frac{25}{35}$.
13. $\frac{1}{2}$ of $\frac{3}{4}$, $\frac{5}{6}$ of $\frac{2}{3}$, $\frac{3}{5}$ of $\frac{1}{4}$.
14. $\frac{3}{5}$ of $7\frac{1}{6}$, $\frac{3}{8}$ of $\frac{4}{7}$ of $8\frac{1}{12}$, $\frac{27}{35}$.

Prob. VI. To reduce fractions from one denomination to another without altering their values.

Rule. If from a lower to a higher name, *multiply* the *denominator* by the number of the lower that makes one of the higher; if from a higher to a lower name, *multiply* the *numerator* thereby.

Ex.—Reduce $\frac{4}{11}$ lb. to the fraction of a cwt.; and £$\frac{2}{9}$ to the fraction of 1d. **Ans.** $\frac{1}{308}$ cwt.; $\frac{160}{3}$d.

$$\text{Here, } \frac{4}{11}\text{ lb.} = \frac{4}{11\times112}\text{ cwt.} = \frac{1}{308}\text{ cwt.; } £\frac{2}{9} = \frac{2\times240}{9}\text{d.} = \frac{160}{3}\text{d.}$$

Reduce,

1. $\frac{4}{9}$ far. to the frac. of £1.
2. $\frac{4}{5}$ sh. 〃 a gu.
3. $\frac{9}{11}$ sh. 〃 fl.
4. $\frac{6}{13}$ cr. 〃 £1.
5. $\frac{4}{7}$ far. 〃 a sh.
6. $\frac{2}{3}$ hf. cr. 〃 £1.
7. $\frac{7}{8}$ d. 〃 a gu.
8. $\frac{6}{7}$ lb. 〃 ton.
9. $\frac{8}{9}$ oz. 〃 cwt.
10. $\frac{4}{5}$ dr. 〃 lb.
11. $\frac{9}{11}$ yd. 〃 ml.
12. $\frac{12}{13}$ sec. 〃 ho.

Reduce,

1. £$\frac{1}{2160}$ to the fr. of a far.
2. $\frac{4}{105}$ gu. 〃 sh.
3. $\frac{9}{32}$ fl. 〃 sh.
4. £$\frac{6}{45}$ 〃 cr.
5. $\frac{1}{84}$ sh. 〃 far.
6. £$\frac{1}{12}$ 〃 hf.-cr.
7. $\frac{1}{252}$ gu. 〃 d.
8. $\frac{1}{3136}$ ton 〃 lb.
9. $\frac{1}{2016}$ cwt. 〃 oz.
10. $\frac{1}{320}$ lb. 〃 dr.
11. $\frac{9}{19360}$ ml. 〃 yd.
12. $\frac{1}{3600}$ ho. 〃 sec.

Ex.—Reduce $\frac{5}{9}$fl. to the fraction of a guin. **Ans.** $\frac{10}{189}$ gu.

$$\text{Here, } \frac{5}{9}\text{fl.} = \frac{5\times2}{9}\text{s.} = \frac{5\times2}{9\times21}\text{g.} = \frac{10}{189}\text{gu.}$$

Reduce,

1. £$\frac{4}{5}$ to the frac. of a gu.
2. $\frac{7}{8}$ cr. 〃 fl.
3. $\frac{3}{4}$ cr. 〃 gu.
4. $\frac{3}{5}$ yd. 〃 E. ell.
5. $\frac{2}{3}$ Fl. ell 〃 E. ell.
6. $\frac{4}{9}$ cr. 〃 gu.

Reduce,

1. $\frac{16}{21}$ gu. to the fr. of £1.
2. $\frac{35}{16}$ fl. 〃 cr.
3. $\frac{5}{28}$ gu. 〃 cr.
4. $\frac{12}{25}$ E. ell 〃 yd.
5. $\frac{2}{5}$ E. ell 〃 Fl. ell.
6. $\frac{20}{189}$ gu. 〃 cr.

Note. In the following questions; reduce the given quantity to the lowest name in it for the numerator, and reduce the denomination, to which it is to be reduced, into the same name, for the denominator.

Reduce,

1. 7d. to the frac. of £1.
2. 4$\frac{1}{2}$d. 〃 a sh.
3. 9$\frac{3}{4}$d. 〃 gu.
4. 19s. 8d. 〃 £.
5. 7s. 8$\frac{1}{4}$d. 〃 £.
6. 4 lb. 3 dr. 〃 cwt.
7. 7$\frac{3}{4}$ dr. 〃 lb. av.
8. 8 dwt. 17$\frac{1}{5}$ g. 〃 lb. tr.
9. 7 gal. 3$\frac{1}{5}$ pt. 〃 qr.
10. 5d. 3h. 17m. 〃 ye.
11. 5 yd. 2$\frac{1}{5}$ ft. 〃 ml.
12. 3 ro. 5 per. 〃 ac.

Reduce,

13. 284 po. to the fr. of a ml.
14. 8$\frac{3}{4}$d. 〃 cr.
15. 6s. 10$\frac{1}{2}$d. 〃 hf.-gu.
16. 13 lb. 4 oz. 〃 ton.
17. 7 dwt. 13 g. 〃 oz.
18. 8 gal. 7 pt. 〃 qr.
19. 17 gal. 5 pt. 〃 qr.
20. 3 bu. 3 pk. 〃 qr.
21. 5 oz. 7 gr. 〃 lb. tr.
22. 2 ro. 17 per. 〃 ac.
23. 24 sec. 〃 ho.
24. 15 ho. 15 m. 〃 da.

25. Reduce £3, 17s. 6d. to the fraction of £13, 11s. 3d.
26. What part of 3 cwt. 3 qr. is 2 cwt. 3 qr. 21 lb.?
27. Reduce 4 lb. 3 oz. 15 dwt. to the frac. of 7 lb. 8 oz.

Prob. VII.—To find the value of a fraction.

Rule. Divide the numerator, as so many of the given name, by the denominator as in Compound Division.

Ex.—Find the value of £$\frac{7}{12}$. **Ans.** 11s. 8d.

Here, £$\frac{7}{12}$ = £7, 0s. 0d. ÷ 12 = 11s. 8d.

Find the values of,

1. £$\frac{7}{240}$.
2. $\frac{3}{8}$ sh.
3. $\frac{13}{336}$ gu.
4. £$\frac{59}{60}$.
5. £$\frac{37}{96}$.
6. $\frac{1027}{58872}$ cwt.
7. $\frac{31}{1024}$ lb. av.
8. $\frac{523}{14400}$ lb. tr.
9. $\frac{37}{320}$ qr. (corn).
10. $\frac{7397}{525600}$ year.
11. $\frac{43}{13200}$ mile.
12. $\frac{25}{32}$ acre.
13. $\frac{71}{80}$ mile.
14. $\frac{7}{48}$ crown.
15. $\frac{65}{84}$ half-gu.
16. $\frac{53}{8960}$ ton.
17. $\frac{181}{480}$ oz. tr.
18. $\frac{71}{512}$ qr. (corn).
19. $\frac{141}{512}$ quarter.
20. $\frac{15}{32}$ qr. (corn).
21. $\frac{2407}{5760}$ lb. tr.
22. $\frac{97}{160}$ acre.
23. $\frac{1}{150}$ hour.
24. $\frac{61}{96}$ day.

ADDITION OF VULGAR FRACTIONS.

Rule. Reduce the fractions to their least common denominator if they have not one; add the numerators, and under their sum write the common denominator.

Ex.—Find the sum of $\frac{7}{12}$, $\frac{8}{15}$, and $\frac{7}{40}$. Ans. $1\frac{7}{24}$.

Here, $\frac{7}{12}+\frac{8}{15}+\frac{7}{40}=\frac{70+64+21}{120}=\frac{155}{120}=1\frac{7}{24}$.

1. $\frac{7}{8}+\frac{9}{14}+\frac{6}{7}$.	6. $\frac{13}{24}+\frac{11}{18}+\frac{10}{21}$.
2. $\frac{5}{11}+\frac{6}{11}+\frac{8}{11}$.	7. $\frac{7}{8}+\frac{14}{15}+\frac{13}{27}+\frac{1}{2}$ of $\frac{5}{8}$.
3. $\frac{3}{7}+\frac{4}{9}+\frac{1}{5}+\frac{6}{35}$.	8. $\frac{4}{7}$ of $\frac{7}{11}+\frac{12}{17}+\frac{13}{22}$.
4. $\frac{24}{37}+\frac{13}{23}+\frac{14}{17}$.	9. $\frac{7}{9}$ of $\frac{12}{13}+\frac{8}{9}$ of $\frac{11}{19}$.
5. $\frac{2}{3}$ of $\frac{7}{8}+\frac{5}{11}$ of $\frac{1}{2}$.	10. $\frac{2}{3}$ of $1\frac{1}{4}+\frac{3}{11}+\frac{8}{9}$ of $\frac{3}{5}$.

Note 1. When mixed numbers are given, find the sum of the fractions as before, to which add the integers.

11. $4\frac{1}{2}+7\frac{1}{3}+8\frac{4}{5}$. | 12. $9\frac{1}{4}+6+8+11\frac{1}{5}$.

13. $\frac{7}{8}+6\frac{3}{11}+14\frac{1}{3}+51\frac{3}{4}$.

Note. 2. When the fractions are of different names, reduce them to the same name by Prob. VI., and add; or find their values by Prob. VII., and add as in Compound Addition.

Ex. £$\frac{7}{12}+\frac{5}{8}$cr. $+\frac{3}{4}$s. Ans. 15s. $6\frac{1}{2}$d.

Here, £$\frac{7}{12}+\frac{5}{8}$cr. $+\frac{3}{4}$s. = 11s. 8d. + 3s. $1\frac{1}{2}$d. + 9d. = 15s. $6\frac{1}{2}$d.

14. $\frac{7}{8}$ sh. + £$\frac{4}{11}+\frac{3}{4}$d.	19. $\frac{5}{8}$ yd. + $\frac{3}{5}$ En. ell + $\frac{2}{3}$ Fl. ell.
15. $\frac{3}{4}$ sh. + £$\frac{5}{8}+\frac{6}{7}$ gu.	20. $\frac{3}{5}$d. + $\frac{5}{8}$s. + £$\frac{5}{7}+\frac{7}{8}$ gu.
16. $\frac{1}{4}$ lb. + $\frac{1}{7}$ oz. + $\frac{3}{5}$ dwt.	21. $\frac{1}{3}$ lb. + $\frac{3}{5}$ cwt. + $\frac{5}{8}$ ton.
17. $\frac{3}{5}$ cr. + £$\frac{5}{12}+\frac{8}{15}$ gu.	22. $\frac{3}{5}$ qr. + $\frac{2}{3}$ bush. + $\frac{3}{5}$ peck.
18. $\frac{7}{12}$ sh. + £$\frac{13}{14}+\frac{16}{18}$ gu.	23. $\frac{3}{5}$ ho. + $\frac{5}{12}$ day + $\frac{4}{7}$ week.

24. A borrowed at one time £$84\frac{7}{11}$, at another £$17\frac{5}{7}$, at another $18\frac{5}{8}$s., and at another $11\frac{3}{8}$d.; how much did he borrow in all?

25. B went to market and bought $4\frac{3}{7}$ cwt. + $18\frac{7}{8}$ lb. + $28\frac{13}{14}$ lb. + $13\frac{3}{4}$ oz. of tea; how much did he buy in all?

26. C went to market and sold $54\frac{1}{2}$ yards + $16\frac{7}{8}$ yards + $30\frac{1}{5}$ English ells + $4\frac{2}{3}$ Flemish ells of cloth; how many yards did he sell in all?

27. A can do a piece of work in 4 days, which B can do in 5 days, C in 6 days, and D in 8 days; what part could the four do in one day?

SUBTRACTION OF VULGAR FRACTIONS.

Rule. Reduce the fractions as in Addition; find the difference of the numerators, and under the remainder write the common denominator.

Note. In mixed numbers, first subtract the fractions, and if the numerator of the subtrahend exceeds that of the minuend, subtract it from the common denominator, and to the remainder add the numerator of the minuend for the numerator of the fraction; then *carry* one to the units' place of the subtrahend, and proceed as in Simple Subtraction.

Ex.—From $\frac{7}{11}$ of $18\frac{1}{3}$ take $\frac{5}{16}$. Ans. $11\frac{17}{48}$.

Here, $\frac{7}{11}$ of $18\frac{1}{3} - \frac{5}{16} = \frac{35}{3} - \frac{5}{16} = \frac{560-15}{48} = \frac{545}{48} = 11\frac{17}{48}$.

1. $\frac{4}{5} - \frac{5}{12}$
2. $\frac{13}{18} - \frac{5}{16}$
3. $\frac{9}{11} - \frac{3}{17}$ of $\frac{1}{2}$
4. $\frac{24}{35} - \frac{16}{49}$
5. $\frac{11}{54} - \frac{3}{28}$ of $\frac{5}{6}$
6. $\frac{9}{11} - \frac{1}{13}$ of 4
7. $6\frac{1}{5} - 4\frac{3}{4}$
8. $7\frac{5}{12} - 3\frac{1}{2}$
9. $8\frac{1}{2} - 4\frac{1}{4}$
10. $15 - \frac{3}{7}$
11. $18 - 5\frac{3}{8}$
12. $13\frac{7}{8} - 4\frac{4}{7}$
13. £$\frac{7}{11} - \frac{7}{12}$ sh.
14. £$\frac{13}{15} - \frac{4}{7}$ cr.
15. £$\frac{8}{9} - \frac{7}{11}$ gu.
16. £$\frac{3}{4} - \frac{1}{7}$ gu.
17. $\frac{4}{7}$ cwt. $- \frac{3}{14}$ qr.
18. $\frac{8}{11}$ ml. $- \frac{3}{4}$ fa.

19. Paid a debt of £$7\frac{4}{11}$ out of a purse containing $9\frac{1}{12}$ guineas; how much remained?

20. A's share of a ship was $\frac{27}{35}$, of which he sold $\frac{3}{4}$; how much remained?

21. A person who had $13\frac{5}{8}$ yards of cloth, sold $7\frac{3}{4}$ yards; how much remained?

22. What part of a ship remained after selling $\frac{4}{7}$ of $\frac{5}{8} +$ $\frac{1}{5}$ of $\frac{3}{7}$ of it?

23. Sold $\frac{3}{5}$ of $\frac{5}{6} + \frac{2}{3}$ of $\frac{3}{7}$ of a gallon of wine; what part remained?

MULTIPLICATION OF VULGAR FRACTIONS.

Rule 1. Multiply all the numerators together for the numerator of the product; and all the denominators together for the denominator.

Rule 2. Strike out the factors common to the numerators and denominators; then multiply as directed.

Note. Reduce mixed numbers to improper fractions.

Ex.—Multiply $6\frac{4}{11}$ by $\frac{22}{35}$ and by $\frac{5}{9}$. Ans. $2\frac{2}{9}$.

Here, $\frac{70}{11} \times \frac{22}{35} \times \frac{5}{9} = \frac{2}{1} \times \frac{2}{1} \times \frac{5}{9} = \frac{20}{9} = 2\frac{2}{9}$.

1. $\frac{4}{5} \times \frac{11}{12}$
2. $\frac{4}{13} \times \frac{4}{27}$
3. $\frac{13}{37} \times \frac{18}{43}$
4. $\frac{7}{11} \times \frac{8}{9}$ of $\frac{3}{5}$
5. $\frac{9}{11} \times \frac{5}{8}$ of $\frac{7}{11}$
6. $8 \times \frac{10}{11}$ of $\frac{11}{14}$
7. $8\frac{3}{4} \times \frac{5}{12}$
8. $7 \times \frac{5}{13}$
9. $16 \times \frac{3}{4}$
10. $5\frac{3}{8} \times 11\frac{1}{4}$
11. $18\frac{3}{16} \times 11\frac{3}{4}$
12. $3\frac{5}{8} \times 4\frac{5}{6}$
13. $(\frac{3}{7}$ of $\frac{5}{9} + \frac{2}{3}$ of $\frac{5}{14}) \times (7\frac{3}{11}$ of $6\frac{5}{12} - 3\frac{5}{9}$ of $\frac{21}{56})$.
14. $(5\frac{1}{3}$ of $7\frac{5}{32} - \frac{6}{13}$ of $\frac{52}{42}) \times (\frac{16}{25}$ of $\frac{45}{56} + 7\frac{1}{2}$ of $\frac{16}{21})$.
15. What is the value of $\frac{5}{8}$ yds. cloth, at £$\frac{17}{18}$ per yd.?
16. What is the value of $\frac{3}{7}$ acre, at £$2\frac{3}{11}$ per acre?
17. What is the value of $17\frac{5}{11}$ yds., at $7\frac{5}{18}$s. per yard?
18. What is the value of $37\frac{3}{5}$ Eng. ells, at $5\frac{3}{7}$d. per yd.?
19. What is the value of $\frac{4}{7}$ oz. of silver, at £$3\frac{5}{8}$ per lb.?
20. What is the value of $60\frac{3}{5}$ gal., at £$50\frac{4}{5}$ per 252 gal.?

DIVISION OF VULGAR FRACTIONS.

Rule. Invert the divisor, and proceed as in Multiplication of Fractions.

Ex.—Divide $\frac{7}{11}$ of $\frac{8}{9}$ by $\frac{7}{45}$. Ans. $3\frac{7}{11}$.

Here, $\frac{7}{11}$ of $\frac{8}{9} \div \frac{7}{45} = \frac{56}{99} \times \frac{45}{7} = \frac{8}{11} \times \frac{5}{1} = \frac{40}{11} = 3\frac{7}{11}$.

1. $\frac{11}{15} \div \frac{11}{12}$
2. $\frac{16}{351} \div \frac{4}{27}$
3. $\frac{216}{1591} \div \frac{18}{43}$
4. $\frac{56}{165} \div \frac{8}{9}$ of $\frac{3}{5}$
5. $\frac{315}{968} \div \frac{9}{11}$
6. $5\frac{5}{7} \div \frac{5}{7}$
7. $3\frac{31}{48} \div \frac{5}{12}$
8. $2\frac{9}{13} \div \frac{5}{13}$
9. $12 \div \frac{3}{4}$
10. $60\frac{15}{32} \div 11\frac{1}{4}$
11. $213\frac{45}{64} \div 11\frac{3}{4}$
12. $17\frac{25}{48} \div 4\frac{5}{6}$

13. $(4\frac{1}{2}$ of $\frac{26}{27} + \frac{4}{11}$ of $5\frac{1}{2}) \div (7\frac{7}{18}$ of $\frac{27}{56} - \frac{14}{21}$ of $\frac{25}{72})$.

14. $(7\frac{4}{11}$ of $\frac{13}{18} - \frac{1}{2}$ of $\frac{16}{25}) \div (4\frac{1}{7}$ of $\frac{21}{87} + 2\frac{1}{3}$ of $\frac{16}{21})$.

15. If $7\frac{5}{7}$ yds. of lawn cost $38\frac{7}{8}$s.; what is it per yd.?

16. A farm of $17\frac{8}{11}$ acres was rented at £$14\frac{7}{15}$; what was the rent per acre?

17. What is the price of cloth per yard, when 7 pieces, each $11\frac{3}{5}$ yards, cost £$54\frac{3}{8}$?

18. A man performed a piece of work in $6\frac{13}{18}$ days; what part of the work did he perform in one day?

19. How many stones, each $13\frac{4}{5}$ inches by $7\frac{1}{4}$, will lay a kitchen $40\frac{7}{8}$ feet long, and $32\frac{3}{4}$ feet broad?

20. Divide a ship valued at £$980\frac{7}{11}$ into $21\frac{3}{7}$ shares; and a prize of £1000 into $42\frac{5}{8}$ shares.

EXERCISES IN VULGAR FRACTIONS.

1. The number 12 may be expressed by a certain digit repeated four times; so also may the numbers 23, 34, 45, etc., etc., by certain other digits; required the digits and manner of placing them.

2. The number 10 may be expressed by a certain digit repeated thrice; the number 100 by the same digit repeated four times; the number 1000 by the same digit repeated five times, and so on, *ad infinitum;* required the digits and manner of placing them.

3. A jeweller bought 3 pieces of silver; the 1st weighed $3\frac{7}{8}$ lb.; 2d, $11\frac{5}{6}$ oz.; 3d, $17\frac{3}{5}$ dwt.; what did he pay for the whole, at £$5\frac{7}{12}$ per lb.?

4. A shipowner sold $\frac{1}{4}$ of $\frac{3}{5}$ of a vessel to one person, and $\frac{5}{7}$ of $\frac{5}{8}$ of it to another; what part had he remaining?

5. From a cask containing 70 gallons of wine, there was drawn off $\frac{3}{8}$ of $52\frac{1}{2}$ gallons $+$ $\frac{3}{7}$ of $52\frac{1}{2}$ gallons $+$ $\frac{4}{5}$ of 15 gallons; how many gallons remained?

6. What is the difference between $\frac{3}{4}$ of a bushel and $\frac{7}{11}$ of a peck; also between $\frac{1}{5}$ of a gallon and $\frac{13}{14}$ of a pint?

7. What is the weight of a box of goods $4\frac{1}{4}$ feet long, $3\frac{3}{8}$ feet broad, and $21\frac{7}{12}$ in. thick, at $4\frac{3}{4}$ lb. per cubic foot?

8. What is the price of a piece of wainscot $7\frac{1}{8}$ feet in length, and $23\frac{5}{12}$ inches in breadth, at $17\frac{3}{5}$d. per sq. foot?

9. A lady's fortune was $\frac{4}{5}$ of $\frac{7}{8}$ of her brother's, which was valued at £3000; what was the lady's fortune?

10. Divide £$876\frac{3}{7}$ into $11\frac{3}{5}$ shares.

11. Divide £$78\frac{2}{5}$ among four men and two women, and give each of the women $\frac{1}{3}$ of a man's share.

12. A person having $\frac{3}{8}$ of a copper-mine, sells $\frac{3}{5}$ of his share for £396; what was the whole mine worth?

13. What number is that $\frac{4}{11}$ of which is 76?

14. What number diminished by $\frac{3}{5}$ of itself becomes 942?

15. What part of 10 guineas is $\frac{5}{8}$ of £3, 10s.?

16. A father's age is 66 years, 6 years since his son's age was $\frac{5}{12}$ of his; what is the son's age now?

17. A can do a piece of work in 4 days, which B can do in 5, and C in 6 days; what part will they all do in 1 day?

18. A and B can do a piece of work in $3\frac{1}{3}$ days, which A alone can do in 6 days; what part of it can each alone do in one day?

19. Divide 41 cwt. 1 qr. 5 lb. among 7 men, 8 women, and 9 children, giving each woman $\frac{4}{5}$ of a man's share, and each child $\frac{1}{4}$ of a woman's share.

20. Simplify $(16\frac{2}{3} + 4\frac{1}{5} - 7\frac{2}{9}) \times \frac{5}{18} \div 2\frac{7}{11}$.

21. A father left $\frac{7}{18}$ of his estate to his only daughter, and the remainder to his only son, the difference of the legacies was £3696; what was the value of the estate?

22. A person has $\frac{7}{9}$ of a ship worth £4500; he sells $\frac{1}{3}$ of his share to A, and $\frac{2}{3}$ of $\frac{3}{4}$ of the remainder to B; what part has he left, and what is its value?

23. How many yds. of paper, $\frac{3}{4}$ yd. broad, will line a room 24 ft. 8 in. by 18 ft. 11 in., and 11 ft. 2 in. high?

24. A bankrupt's effects amount to $\frac{3}{5}$ of his debts; what is that per pound?

25. What number divided $1\frac{9}{11}$ of $7\frac{1}{3}$, and the quotient multiplied by $\frac{4}{7}$ of $16\frac{2}{3}$ will give for the product $\frac{2}{3}$ of $4\frac{1}{5}$ of 36?

26. In a certain number of coins $\frac{1}{18}$ of the whole are sixpences, $\frac{1}{12}$ are shillings, $\frac{1}{9}$ are florins, and there are 111 crowns; find the number?

27. What part of a lb. avoir. is $\frac{19}{25}$ lb. tr.?

28. Find the value of $17\frac{5}{8}$ lb. at $11\frac{1}{5}$d. per lb.

29. Divide £534, 11s. $6\frac{1}{2}$d. among 7 men, 8 women, and 15 children, giving a woman $\frac{3}{4}$ of a man's share, and a child $\frac{4}{5}$ of a woman's share.

30. A starts from a certain place travelling 20 miles an hour, after $2\frac{1}{2}$ hours B starts to overtake him, at the rate of $26\frac{2}{3}$ miles an hour; when will B overtake A, and how far will each have travelled?

31. Find the three least whole numbers, of which $\frac{2}{3}$ of the first, $\frac{3}{4}$ of the second, and $\frac{4}{5}$ of the third make the same number.

32. A captain sends out 20 more than $\frac{1}{3}$ of his men, and has left 20 more than $\frac{1}{2}$; how many men had he in command?

RATIOS AND PROPORTION.

Ratio is the relation which one number, called the *antecedent*, has to another of the same kind called the *consequent*. The value of a ratio is determined by the number [illegible] antecedent contains the consequent, thus: [illegible] to 16, written 48 : 16, is $\frac{48}{16} = 3$, for 48 contains 16 exactly three times; so also £24: £48 is $\frac{24}{48} = \frac{1}{2}$, for 24 is one half of 48.

The value of a ratio is not altered by multiplying or dividing its terms by the same number; ratios are compared by reducing their fractional equivalents to a common denominator.

Proportion or analogy consists in equality of ratios; thus, since 24 : 72 = 21 : 63, the numbers 24, 72, 21, and 63 are proportionals; the proportion is written 24 : 72 : : 21 : 63, and is read, as 24 is to 72 so is 21 to 63: the first and last terms are called the extremes, the others the means. When four numbers are proportional, the product of the *extremes* is always equal to the product of the *means;* thus, in the above proportion, 24 × 63 = 72 × 21, so that when any three terms of a proportion are given, the remaining one may be found.

SIMPLE PROPORTION.

When the first three terms of a proportion are given, the object of this rule is to find the fourth term; of the three given terms, two are always of the same kind and the other is of the same kind as the required term.

When the terms are so connected that the one increases as the other increases, or diminishes as the other diminishes, the proportion is said to be *direct;* but if the one increases as the other diminishes, or the contrary, the proportion is said to be *inverse.*

RULE 1. Place the term which is of the same kind as that required, for the third or right-hand term.

2. Consider from the nature of the question, whether the answer is to be greater or less than the term written down; if *greater*, place the *greater* of the two like terms in the middle, and the other on the left; but if *less*, place the *less* in the middle and the other on the left.

3. Reduce the first and second terms to the same name, and the third term to the lowest name in it; then multiply the second and third terms together, and divide the product by the first term for the answer in that name to which the third term was reduced.

Ex. 1.—If 12 acres of land maintain 16 horses; how many horses will 27 acres maintain?

Since horses are required, 16 is placed on the right; and as 27 acres will maintain more horses than 12 acres, 27 is placed in the middle, and 12 on the left; then 27 × 16 = 432, and 432 ÷ 12 = 36 horses.

$$\begin{array}{l} 12\text{ ac.} : 27\text{ ac.} :: 16\text{ ho.} \\ \qquad\qquad 16 \\ \qquad\quad \overline{162} \\ \qquad\quad 27 \\ \qquad 12)\overline{432} \\ \qquad\quad \underline{\underline{36}}\text{ horses.} \end{array}$$

This question may also be solved thus: since 12 acres supply 16 horses, 1 acre would supply $\frac{16}{12}$ or $1\frac{1}{3}$ horses, and 27 acres would evidently maintain $\frac{16 \times 27}{12} = \frac{432}{12} = 36$ horses.

Ex. 2.—If 6 cwt. 3 qrs. of tea cost £170, 2s.; what should 3 cwt. 2 qrs. 14 lb. cost? Ans. £91, 7s.

Having stated the question as before, and reduced the 1st and 2d terms to lb., and the 3d to shil., they are then operated upon as directed for the answer in shillings, which are reduced to £'s.

$$\begin{array}{l} 6\text{ cwt. }3\text{ qrs.} : 3\text{ cwt. }2\text{ qrs. }14\text{ lb.} :: £170,\ 2\text{s.} \\ \quad 756\text{ lb.} \qquad\quad 406\text{ lb.} \quad \times \quad 3402\text{s.} \\ \qquad\qquad\qquad 756)\overline{1381212} \\ \qquad\qquad\qquad\quad 2,0)\overline{182,7\text{s.}} \\ \qquad\qquad\qquad\qquad \underline{\underline{£91,\ 7\text{s.}}} \end{array}$$

Note 1.—If the first and either of the other terms can be measured by the same number, the quotients may be used instead of the original numbers.

1. If 4 yds. of cloth cost 3s.; what will 24 yds. cost?
2. If 24 yds. of cloth cost 18s.; what will 4 yards cost?
3. If 4 yds. of cloth cost 3s.; how many will cost 18s.?
4. If I get 24 yds. for 18s.; how many will I get for 3s.?

Note 2.—Each question admits of being varied in the same way as these four.

5. If 24 yds. of cloth cost 36s.; what will 141 yds. of the same cost?
6. If 8 yds. cost 32s.; what will 51 yds. cost?
7. If 7 lb. cost 25s.; what will 49 lb. cost?
8. If 17 yds. of cloth cost £4, 5s.; what will 307 yds. of the same cost?
9. If 7 yds. cotton cost 10s. 6d.; what will 99 yds. of the same cost?

10. If 100 yds. of muslin cost £5, 8s. 4d.; what will 37 yds. cost?

11. If 68 yds. of cloth cost £17, 19s. 10d.; what will 7 yds. cost?

12. If 57 yds. of linen cost £8, 11s.; what will 98 yds. 3 qrs. cost?

13. If 19 lb. of tea cost £4, 15s.; what will 3 cwt. 17 lb. cost?

14. If 47 yds. of velvet cost £34, 10s. 3¾d.; what will 117 yds. cost?

15. If 57 yds. of scarlet cost £55, 4s. 4½d.; what will 4 pieces, each 38 yds., cost?

16. If 41 hhds. of wine cost £287, 2s. 6¾d.; what will 33 hhds. cost?

17. If 51 lb. Bohea tea cost £19, 12s. 0¾d.; what will 7 canisters, each containing 2 cwt. 3 qrs. cost?

18. How much tea may be bought for £7, 8s. 5¼d., when 14 cwt. 3 qrs. cost £872, 16s. 3d.?

19. How much steel may be bought for £9, 16s. 10½d., when 14 lb. cost 10s. 11¼d.?

20. How many figs may be bought for £1, 17s. 0¾d., at £47, 1s. 3d. for 1½ ton?

21. What is a man's wages for 73 days, at £37, 4s. 1d. per annum?

22. What is the price of 3 pieces of cloth, each containing 25 yds., at £4, 19s. 11½d. for 17 yds.?

23. What is the price of 57 English ells, at £1, 9s. 2d. for 25 yards?

24. What is the price of 7⅜ English ells, at £8, 12s. for 14 French ells?

25. What is the price of 12 pieces of cloth, each containing 25½ yards, at £20, 4s. 8d. for 47 Flemish ells?

26. What is the price of 6 cheeses, each 14¾ lb., at 5¾d. per lb.?

27. What is the price of 56 cwt. 3 qr. 14 lb. of sugar, at 15s. 4½d. for 18 lb.?

28. What is the price of 3031 gallons of beer, at £4, 6s. 7d. for 54 gallons?

29. What is the price of 207 acres, 15 perches of land, at £26, 17s. 6d. per acre?

30. What is the price of 3456 gallons, 7 pints of ale, at 36s. 8¼d. per 36 gallons?

31. How much cloth, at 23s. 4d. per yd., should I get for 97¼ cwt. of sugar, at 9¾d. per lb.?

32. Exchanged 156 yards of cloth, at 16s. 10d., for 936 yards of linen; what did the linen cost per yard?

33. Exchanged 67 cwt. of tobacco, at 8 guineas per cwt., and received in part 600 lb. tea at 7s. 4d., and for the rest I received stockings, at 2s. 8d. per pair; how many pairs of stockings did I receive?

34. What is the price of 17 gallons of oil, at £37, 16s. for 84 gallons?

35. What is the price of 7 pieces of silver, each 4 lb. 15 dwt., at 18 guineas for 72 ounces?

36. What is the price of 574 gallons of wine, at £4, 2s. 6d. for 49 gallons?

37. What is the price of 7 cwt. 3 qr. 18 lb. of sugar, at 4s. 4⅓d. for 11 lb.?

38. What is the price of 15 cwt. 27 lb. of tea, at £3, 7s. 4½d. for 7 lb.?

39. What is the price of 3 cwt. 16 lb. of iron, at 7s. 1d. for 17 lb.?

40. What is the price of 56 packs of wool, each 114 stone, at £13, 17s. 2¾d. for 28 stone?

41. If 42 men perform a piece of work in 108 days; in what time will 72 men do it?

42. If 18 men mow a meadow in 4 days; how many men will mow it in 9 days?

43. If 57 masons build a house in 156 days; in what time will 37 masons do the same?

44. If 28 persons reap a harvest in 36 days; how many persons will reap it in 9 days?

45. If the 9d. loaf weighs 4 lb. 6 oz. when wheat is at 4s.; how much should it weigh, when wheat is at 3s. 9d.?

NOTE 3. When the same term is twice mentioned in a question, it must be excluded.

46. If the 6d. loaf weighs 3 lb. when wheat is at 4s. 6d.; what is the price of the same quantity of wheat when it weighs 2 lb. 11 oz. 3⅕ drs.?

47. Exchanged 84 qrs. of wheat, at 84s. per qr., and received ⅔ of the value in rum, at 16s. 8d. per gallon, and the rest in sugar, at 8⅓d. per lb.; how much did I receive of each?

48. Exchanged 154 yards of cloth at 14s. 10d. per yd.; for every 2 yards of cloth that I gave, I got in return 7 yards of muslin: how much muslin did I get, and what did it cost per yard?

49. Exchanged 38 doz. pairs of shoes, at 7s. 8d. per pair, and got for them equal quantities of raisins, at 9½d. per lb., and figs at 5¼d. per lb.; how much did I receive of each?

50. If a garrison of 2000 men have provisions for 6 months; how many men will the same serve 8 months?

51. If I lend a friend £275 for 9 months; how long must he lend me £1925 to return the favour?

52. If 1787 cwt. 2 qr. of lead cost £907, 10s.; what is that per fodder of 19½ cwt.?

53. What is the price of silver per lb., when 4 lb. 10 oz. cost £24, 17s. 10d.

54. If a lb. of silver cost £4, 16s. 6d.; what is the price of 7 pieces, each 3¾ lb.?

55. If the 6d. loaf weighs 3 lb. when wheat is at 34s.; how much should it weigh when wheat is at £1, 5s.?

56. If the 6d. loaf weighs 4 lb. 9 oz. when wheat is sold at £1, 6s. 6d.; what is the price of wheat when it weighs 3 lb. 3 oz. $9\frac{29}{75}$ drams?

57. A gives to B 96 gallons of brandy, at 23s. 8d. per gallon, and gets in return 60 guineas and 450 yards of linen; what was the linen valued at per yard?

58. A barters silk stockings at 15s. with B for hats at 18s.; but the stockings were worth only 13s. 4d., and the hats worth 16s.; which of them was the gainer?

59. Exchanged 9 cwt. of snuff at £8, 15s., and got for it hemp at 9d. per lb., and flax at 1s. 4d.; there was four times as much hemp as flax: how much did I get of each?

60. A bankrupt owes his creditors £4678; how much will he pay them at 11s. 6d. per pound?

61. How many men were in that garrison, which consumed as much in 7 months as a garrison of 900 men consumed in one year and nine months?

62. A bankrupt pays his creditors 13s. 4d. per pound, paying them in all £490; what was his debt?

63. If a garrison of 1000 soldiers have provisions for 9 months; how many must be dismissed that the same provisions may last 15 months?

64. If 37¼ yards of paper, yard-wide, be sufficient to paper a room; how many yards, 5 quarters wide, will do it?

65. What is the tax upon a house of £340 rent, at 3s. 6d. per £1?

66. A bankrupt, who owes his creditors £960, pays them only £504; how much does he pay them per £1?

67. A garrison has provisions for 10 months, at the rate of 16 oz. to each person per day; how much may each be allowed per day, that the provisions may last one year?

68. At 15 oz. per day for each man, a garrison's provisions will last 8 months; how long will they last if each man is only allowed 12½ ounces?

69. What is the interest of £1750 for a year at £5 per cent. per annum, or £5 interest on £100 for a year?

70. What is the commission on £256, 18s., at £2¼ per cent.?

71. What is the interest of £650, at £4 per cent.?

72. What is the brokerage of £255, at 4s. per cent.?

73. What is the factorage of £375, at £2½ per cent.?

74. If £425 gain £20, 3s. 9d.; what is the rate per cent.?

75. Exchanged 27 cwt. of cheese, at 93s. per cwt., and received for it wool at 13s. per stone, and butter at 22s. per stone; for every 3 stones of butter, I got 7 stones of wool: how much did I receive of each?

76. A has 96 gals. of gin worth 16s. 6d., which he wishes to exchange with B for wine worth 2 guineas per dozen; but B demands 45s. for his wine in barter: how much should A demand for his gin, not to be a loser, and how much wine should he get for it?

77. What principal will gain £64, 5s. 6d. in a year, at £5 per cent. per annum?

78. If £125 in 8 months gain a certain sum of interest; what principal will gain the same in 6 months?

79. A train runs 435 miles in 10 hours 30 minutes; in what time will it run 87 miles?

80. A farmer borrowed 192 quarters of wheat, when the price was £4, 11s.; how much should he return in quantity when the price is 4 guineas?

81. If 56 tenpence loaves can be got from a quarter of wheat; how many eightpence-loaves should be got from it?

82. If 20 acres of land, worth 20 guineas per acre, be

exchanged for 35 acres of other land; what is this last valued at per acre?

83. A cistern of 230 gallons has a pipe which discharges 5¾ gallons in a minute, and another has a pipe which discharges 6⅗ gallons in a minute; both cisterns are emptied in the same time: how many gallons does the last cistern contain?

84. At what time after 6 o'clock are the hour and minute hands of a clock exactly together?

85. If the flooring of a room, 24 feet by 18, cost £17, 2s.; what will be the cost of one 30 feet by 22?

86. How much cloth, at 7s. 6d. per yard, ought to be given in barter for 3 pieces of other cloth, each 27 yards, at 5s. 3d. per yard?

87. Bought a quantity of cloth for £19, 12s. 0¾d., for which I paid at the rate of 7s. 8¼d. per yard; required how many yards were in the whole.

88. If the carriage of 169 cwt. 2 qr., for 130 miles, is £34; what weight may I have carried 78 miles for the same money?

89. Bartered 64 yards of linen at 2s. 8d. per yard, for 128 yds. of cotton; required the barter price of the latter.

90. If the carriage of 60 cwt. for 120 miles is £15, 10s.; how far may I have 210 cwt. carried for the same money?

91. A has tea worth 7s. 6d. ready money, but in barter will have 9s.; B has cloth worth 2s. 6d. ready money: how must B rate his cloth to be even with A?

92. How many yards of cloth, at 7s. 6d. per yard, ought to be received for 7 pieces, each 108 yards, at 5s. per yard?

93. A merchant consigns 32 bales of cloth, at £172, 5s. per bale, to his agent, who, after retaining commission at 5 per cent., sends him in return one-half of the value in sugar at 44s. per cwt., and the other half in rum at 4s. 8d. per gallon; what quantity of each did he receive?

94. How much cloth, 3 qrs. wide, must be given for 90 yards of equal quality, which is 5 qrs. wide?

95. A has cloth at 4s. 6d. per yard, which he wishes to barter with B for 84 yards at 7s. 6d.; how many yards must A give?

96. The shadow of a cloud was observed to move 36 yds. in 5 sec.; what was the hourly motion of the wind?

97. Bought 378 gallons of wine for £160, 13s., of which 42 gallons were lost; how should 84 gallons of the remainder be sold, so as neither to gain nor lose?

98. If $\frac{3}{8}$ yard cost £$\frac{7}{18}$; what should $4\frac{3}{4}$ yards cost?

99. What is the price of $5\frac{3}{7}$ yds., at 7s. 6d. for $\frac{3}{4}$ yard?

100. What cost $\frac{7}{18}$ lb. of tea, at 15s. $8\frac{1}{2}$d. for $3\frac{6}{7}$ lbs.?

101. What cost 8 cwt. 3 qrs., at 14s. 8d. for $\frac{7}{8}$ cwt.?

102. What cost $15\frac{5}{8}$ yards of silk, at 8s. 9d. per yard?

103. What cost $17\frac{3}{4}$ yds., at 11s. 8d. for $5\frac{3}{8}$ English ells?

104. What cost 3 chests of tea, each 3 cwt. 14 lb., at 5s. 7d. for $1\frac{1}{6}$ lb.?

105. If $\frac{4}{7}$ of a ship be worth £920; what is $\frac{1}{5}$ of it worth?

106. The rent of $\frac{12}{14}$ of a meadow was £3, 12s.; what will be the rent of $\frac{5}{8}$ of $\frac{7}{18}$ of it at that rate?

107. How many yards of cloth, at 8s. 4d. per yard, must be given for 44 English ells 3 qrs., at 10s. 6d. per ell?

108. The height of my staff from the ground is 5 feet 10 in., and it casts a shadow of 6 ft. 5 in.; what is the height of a steeple which casts a shadow of 220 ft. 6 in.?

109. If $\frac{7}{11}$ of a house cost £360; what will $\frac{17}{34}$ of it cost?

110. A lends B £$454\frac{3}{8}$ for $6\frac{1}{8}$ months; how long must B lend A £$204\frac{1}{8}$ to discharge the obligation?

111. A can do a piece of work in 18 days, B the same in 20 days, and C in 24 days; in what time will they perform it working together?

112. What is the price of a silver teapot weighing $1\frac{5}{7}$ lb., at £$\frac{5}{8}$ for $1\frac{5}{7}$ ounce?

113. What cost $13\frac{1}{2}$ oz. silver, at £52, 16s. for $18\frac{5}{7}$ lb.?

114. If cloth, when $\frac{5}{8}$ yard wide, costs $3\frac{5}{8}$s.; what is the price of the same cloth when $\frac{9}{8}$ yard wide?

115. A shepherd being asked the number of his sheep and goats, answered, that $\frac{1}{2}+\frac{1}{4}+\frac{1}{5}+\frac{1}{8}+\frac{1}{10}+\frac{1}{20}+\frac{1}{40}$ of the number of his sheep was to that of his goats as 5 is to 1; and $\frac{1}{2}+\frac{1}{4}+\frac{1}{5}+\frac{1}{10}+\frac{1}{20}$ of his goats was equal to 110: required the number of his sheep and goats.

116. A can perform a piece of work in 9 hours, B in $8\frac{1}{2}$, and C in $6\frac{3}{4}$ hours; in what time can they perform it all working together?

117. A, B, and C, working together, can finish a piece of work in 8 days, which A can do by himself in 25 days, and B in 22; in what time could C alone do it?

COMPOUND PROPORTION.

When the Proportion depends upon several circumstances, it is said to be compound.

One of the given terms is always of the same kind as that required; and the others, taken two and two together, are like each other.

Rule 1. Place that term which is like the number required, upon the right hand.

2. Take two terms of the same kind, and state them, without any reference to the other similar terms, as in Simple Proportion; again take other two, like one another, and state them in the same way *under* the former, and so on till all the terms are stated.

3. Reduce the *like* terms to the same name and the *third* term to the lowest name in it, then multiply successively the terms under each other, which will reduce them to three, and proceed as in Simple Proportion.

Note. The work may be greatly abridged by cancelling.

Ex. 1.—If 15 pecks of wheat serve 9 persons for 22 days; how long will 20 pecks of it serve 6 persons?

Ans. 44 days.

Days being required, 22 is placed on the right; 20 pks. will serve longer than 15, hence 15 : 20; also the same quantity will serve 6 men longer than 9, hence 6 : 9.

$$\begin{array}{lrcrcl}
\text{Pecks,} & 15 & : & 20 & :: & 22 \text{ days.} \\
\text{Persons,} & 6 & : & 9 & & \\
\hline
 & 90 & : & 180 & :: & 22 \\
 & & & 22 & & \\
\hline
 & 9{,}0 &) & 396{,}0 & & \\
\hline
 & \text{Ans.} & & 44 & \text{days.} &
\end{array}$$

Ex. 2.—If £36 worth of corn serve 18 men for 9 months, when corn is at 64s. per qr.; how many men will £54 worth serve for 6 months, when corn is at 48s. per qr.?

Ans. 54 men.

Having stated the question, arrange the left-hand terms below a line and the others above it as in the margin; then, having cancelled the terms above and below the line as far as possible, divide the product of those above by that of those below the line, for the answer.

$$\begin{array}{lrcrcl}
 & £36 & : & £54 & :: & 18 \text{ men} \\
\text{mo.} & 6 & : & 9 & & \\
\text{sh.} & 48 & : & 64 & &
\end{array}$$

$$\frac{\overset{9}{\cancel{54}} \times 9 \times \overset{4}{\cancel{64}} \times \overset{6}{\cancel{18}}}{\underset{9}{\cancel{36}} \times 6 \times \underset{3}{\cancel{48}}} = 54 \text{ men}$$

1. If 3 boats take 4500 herrings in a week; in what time will 600 boats take 14000000 herrings?

2. If 3000 copies of a book of 11 sheets require 66 reams of paper; how much paper will be required for 5000 copies of a book of 12½ sheets?

3. If 12 ounces of wool make 2½ yards of cloth, 6 quarters wide; how much wool will be required to make 150 yards, 4 quarters wide?

4. If £100 in 12 months gain £5 interest; how much interest will £1650 gain in 3 years and 6 months?

5. If £100 in 365 days gain £5 interest; how much interest will £675 gain in 438 days?

6. If 15 men build 37 roods of a wall in 27 days; how many roods will 74 men build in 63 days?

7. If 84 men mow 72 acres of grass in 15 days; how many acres will 96 men mow in 12 days?

8. If £600 gain £45 in 18 months; how much will £100 gain in 12 months?

9. What is the interest of £650 for 173 days, at £5 per cent. per annum?

10. What is the interest of £375 for 37 weeks, at £5 per cent. per annum?

11. If the interest of £175 for 39 weeks is £5, 18s. 1½d.; what is the rate per cent. per annum?

12. If the interest of £200 for 146 days is £2, 16s.; required the rate per cent. per annum.

13. What principal will clear £88, 2s. 6d. in 5 years, at £3¾ per cent. per annum?

14. How long must £975 be laid out at interest to gain £190, 2s. 6d., at £4½ per cent. per annum?

15. If 236 men eat 160 qrs. of wheat in 108 days; how many qrs. will 76 men eat in a year and 67 days?

16. If a man travel 360 miles in 12 days of 8 hours each; how many miles will he travel in 60 days of 6 hours each?

17. If 24 men, in 36 days of 12 hours each, perform a piece of work; in what time will 30 men accomplish it, when the days are only 8 hours long?

18. If 30 cwt. are carried 15 miles for £5, 8s. 9d.; how many miles ought 90 cwt. to be carried for £29?

19. If the 9d. loaf weighs 3 lb. when wheat is at 10s. per bushel; what is the price per bushel when the penny-loaf weighs 9 ounces?

20. A solid foot of stone was 16 inches broad, and 3 in. thick; required its length.

21. If 18 men eat 16 shillings worth of bread in 3 days, when wheat is at 54s. per qr.; what value of bread will 45 men eat in 27 days, when wheat is at 45s. per qr.?

22. Eight men accomplished 30 yards of ditching in 12 days, working 8 hours per day; in what time will 12 men finish a ditch, supposing its whole length 60 yards, when they work only 6 hours per day?

23. If 12 men build a wall 60 feet long, 4 thick, and 20 in height, in 24 days, working 12 hours per day; what length of wall, 3 feet thick and 12 high, will 18 men build in 18 days, working 8 hours per day?

24. If 27½ yards of cloth $\frac{13}{12}$ yd. wide, cost £10, 13s. 4d.; what will 7¾ yards cost, when only $\frac{11}{12}$ yd. wide?

25. If 13 yards of cloth ¾ yd. wide cost 5 guineas; how much cloth ⅗ Eng. ell wide may be bought for £8, 12s.?

26. If the 2½d. loaf weighs 8⅗ oz., when wheat is at 5s.; what should the 6d. loaf weigh, when wheat is at 8s. 3d.?

27. If 12 men working 10 hours a-day, or 25 boys working 9 hours a-day, can do a piece of work in 16 days; in how many days of 8 hours each, would 16 men and 30 boys do a piece of work 5 times as large?

PRACTICE

Is the method of computing by aliquot parts.

An aliquot part of a number is such that, being taken a certain number of times, it will exactly produce the number; thus, 5 is an aliquot part of 20, for 5 × 4 = 20.

TABLE OF ALIQUOT PARTS.

6d. = ½ sh.	10s. 0d. = £½	10s. 6d. = ½g.	56 lb. = ½ cwt.
4 = ⅓ 〃	6 8 = ⅓	7 0 = ⅓ 〃	28 = ¼ 〃
3 = ¼ 〃	5 0 = ¼	5 3 = ¼ 〃	16 = ⅐ 〃
2 = ⅙ 〃	4 0 = ⅕	3 6 = ⅙ 〃	14 = ⅛ 〃
1½ = ⅛ 〃	3 4 = ⅙	3 0 = ⅐ 〃	8 = $\frac{1}{14}$ 〃
1 = $\frac{1}{12}$ 〃	2 6 = ⅛	2 4 = ⅑ 〃	7 = $\frac{1}{16}$ 〃
of sixpence.	2 0 = $\frac{1}{10}$	1 9 = $\frac{1}{12}$ 〃	14 lb. = ½ qr.
¾d. = ⅛	1 8 = $\frac{1}{12}$	1 6 = $\frac{1}{14}$ 〃	7 = ¼ 〃
½ = $\frac{1}{12}$	1 4 = $\frac{1}{15}$	1 2 = $\frac{1}{18}$ 〃	4 = ⅐ 〃
¼ = $\frac{1}{24}$	1 3 = $\frac{1}{16}$	1 0 = $\frac{1}{21}$ 〃	3½ = ⅛ 〃

Note. In Practice, it is understood that the value of any number of articles at £1, or 1s., or 1 guinea, etc. each, amounts to as many £'s, or sh., or guin., etc., as there are articles.

Case I. When the given price is an aliquot part of £1, or of 1s., or of 1 guinea, etc.

Rule. Write down the value at £1, or at 1s., or at 1 guinea, etc., and take the same part of it that the given price is of £1, or of 1s., or of 1 guinea, for the answer in £'s, or in sh., or in gu., etc.

Note 1. Multiply the remainder, if any, by the given price.

Note 2. When a part of a guinea is taken, call the guineas pounds, and add as many shillings for the answer in £'s.

Note 3. For ¾d., etc., take the part of a sixpence, or of 3d.

Ex. 1.—Value 273 yds. at 4s.
4s. = £⅕)£273, val. at £1.
Ans. £54, 12s. val. at 4s.

Ex. 2.—Value 497 lbs. at 3d.
3d. = ¼s.)497s. val. at 1s.
2,0)12,4s. 3d. val. at 3d.
Ans. £6, 4s. 3d. 〃 〃

Find the value of,

yds., etc.		s.	d.	yds., etc.		s.	d.	yds., etc.		s.	d.
1. 7916	at	5	0	15. 4753	at	3	0	29. 6798	at	0	4
2. 8945	〃	4	0	16. 9578	〃	2	4	30. 7392	〃	6	8
3. 7386	〃	2	0	17. 6759	〃	1	9	31. 9478	〃	1	8
4. 9374	〃	10	0	18. 8275	〃	1	6	32. 5739	〃	0	1½
5. 8539	〃	6	8	19. 7428	〃	0	6	33. 9483	〃	1	3
6. 7482	〃	3	4	20. 4930	〃	0	4	34. 5728	〃	0	0½
7. 5926	〃	2	6	21. 5726	〃	0	3	35. 9453	〃	2	6
8. 8375	〃	1	8	22. 8957	〃	0	2	36. 8257	〃	0	3
9. 7498	〃	1	4	23. 9988	〃	0	1½	37. 7586	〃	3	4
10. 7926	〃	1	3	24. 4862	〃	0	1	38. 9576	〃	0	2
11. 4927	〃	10	6	25. 7528	〃	0	0¾	39. 7493	〃	2	0
12. 7493	〃	7	0	26. 6795	〃	0	0½	40. 8956	〃	0	0¾
13. 5923	〃	5	3	27. 9426	〃	0	0¼	41. 8938	〃	10	0
14. 4729	〃	3	6	28. 8574	〃	4	0	42. 9478	〃	1	4

Case II. When the given price is not an aliquot part of £1, or of 1s., etc.

Rule. Take an aliquot part less than the price; and if the remainder is not a part, take a part less than it, and so on; then add the values at all these prices.

TE 1. After one part is taken, a part of it may be taken.

Note 2. A part greater than the price may be taken, and the difference deducted.

Note. 3. When there are £'s in the price, multiply by them; when there are no pounds given, multiply by the shillings (in some cases), and take parts for the lower names.

Ex. 1.—Val. 573 yds. at 12s.	Ex. 2.—Val. 468 oz. at 5d.
10s. = £½)£573, val. at £1.	4d. = ⅓s.)468s., val. at 1s.
2s. = ⅕ of 10s.)286, 10s. va. at 10s.	156s. 〃 〃 4d.
57, 6 〃 〃 2s.	1d. = ¼ of 4d. 39 〃 〃 1
Ans. £343, 16s. 〃 〃 12s.	2,0)19,5s. 〃 〃 5d.
	Ans. £9, 15s. 〃 〃 5d.

Find the value of,

	lbs.		d.		yds.		s.	d.		yds.		£	s.	d.
1.	749	at	2½	21.	842	at	0	10¼	41.	749	at	0	5	10½
2.	583	〃	1¼	22.	753	〃	0	11	42.	832	〃	0	12	7½
3.	758	〃	1¾	23.	968	〃	0	11¾	43.	968	〃	0	15	4½
4.	196	〃	2¼	24.	574	〃	1	0½	44.	753	〃	0	3	10¾
5.	983	〃	2¾	25.	597	〃	1	1	45.	654	〃	0	11	7¾
6.	567	〃	3¼	26.	279	〃	1	2	46.	593	〃	0	18	6¼
7.	958	〃	3½	27.	528	〃	2	2	47.	567	〃	0	19	4½
8.	673	〃	3¾	28.	795	〃	3	9	48.	836	〃	3	7	6
9.	958	〃	4¼	29.	674	〃	4	6	49.	645	〃	4	8	7
10.	748	〃	4½	30.	827	〃	4	8	50.	769	〃	8	11	6
11.	937	〃	4¾	31.	523	〃	6	3	51.	953	〃	2	9	6
12.	857	〃	5¼	32.	947	〃	7	6	52.	786	〃	4	2	10
13.	586	〃	5½	33.	248	〃	8	4	53.	735	〃	1	11	8
14.	748	〃	5¾	34.	478	〃	11	8	54.	586	〃	2	17	4
15.	926	〃	6¼	35.	576	〃	12	6	55.	637	〃	5	6	8
16.	512	〃	6½	36.	947	〃	13	4	56.	496	〃	1	14	8
17.	648	〃	6¾	37.	847	〃	16	8	57.	536	〃	8	8	8
18.	957	〃	7½	38.	834	〃	2	8	58.	572	〃	19	18	0
19.	682	〃	8¼	39.	576	〃	11	3	59.	652	〃	23	14	0
20.	742	〃	9½	40.	475	〃	9	6	60.	978	〃	9	9	9

Case III. When the price consists of shillings.

Rule. Multiply by one-half of the number of shillings, then double the right-hand figure of the product for shillings, and the rest are pounds.

Note 1. If there are pounds in the price, prefix them to one-half of the shillings, thus: for £5, 12s. multiply by 56.

NOTE 2. When there are pence in the price, take parts of two shillings for them, and if there is a remainder, take the part out of its double considered as shillings.

Ex.—Find the value of 753 cwt., at £1, 16s. 4d.

Value at 2s. = 753 florins.
18 = ½ of 36s.
13544 florins.
4d. = ⅙ fl. 125 1s.
ANS. £1366 19s. value at 36s. 4d.

Find the value of,

	lb.		s.		cwt.		s.		cwt.		£	s.	d.
1.	348	at	2	11.	743	at	19	21.	247	at	2	8	4
2.	957	〃	6	12.	675	〃	27	22.	453	〃	1	14	8
3.	583	〃	8	13.	453	〃	48	23.	657	〃	0	7	3
4.	975	〃	14	14.	595	〃	64	24.	129	〃	0	8	2
5.	685	〃	22	15.	586	〃	53	25.	734	〃	0	9	9
6.	754	〃	38	16.	759	〃	99	26.	678	〃	0	5	11
7.	853	〃	54	17.	576	〃	37	27.	956	〃	0	18	7
8.	976	〃	7	18.	633	〃	115	28.	631	〃	4	9	4
9.	624	〃	13	19.	698	〃	51	29.	593	〃	3	8	5
10.	956	〃	17	20.	943	〃	10½	30.	672	〃	1	19	10

CASE IV. When the quantity contains a fraction.

RULE 1. Value the integers as before; and for the fraction take the same part of the price that the upper figure is of the under; if the upper is not a part of the under figure, divide it into parts.

RULE 2. Consider the integral part of the quantity to be £'s, and annex such a part of £1 as the fraction is of unity; then take parts as before.

Ex.—Find the value of 126⅜ yds., at 18s. 4d. per yd.

10s. = £½)£126 value at £1
£63, 0s. 0d. value at 10s.
5s. = ½ of 10s. 31 10 0 〃 5s.
3s. 4d. = ⅓ of 10s. 21 0 0 〃 3s. 4d.
⅜ or ¼ of 18s. 4d. = 0 4 7 value of ¼ yard.
⅛ = ½ of ¼ of 18s. 4d. = 0 2 3½ 〃 ⅛ 〃
ANS. £115, 16s. 10½d. val. of 126⅜ yds. at 18s. 4d.

Find the value of,

	cwt.		£	s.	d.
1.	$678\frac{1}{3}$	at	1	8	4
2.	$975\frac{1}{3}$	〃	9	8	0
3.	$756\frac{1}{6}$	〃	0	17	6
4.	$579\frac{1}{8}$	〃	4	8	0
5.	$687\frac{1}{4}$	〃	4	8	6
6.	$147\frac{3}{4}$	〃	2	14	4

	cwt.		£	s.	d.
7.	$218\frac{7}{12}$	at	17	8	6
8.	$964\frac{8}{15}$	〃	8	7	6
9.	$964\frac{5}{8}$	〃	0	15	4
10.	$676\frac{2}{3}$	〃	0	18	9
11.	$754\frac{5}{6}$	〃	0	18	7
12.	$996\frac{5}{12}$	〃	1	3	4

Case V. When the quantity is compound, and the price of the highest name is given.

Rule 1. Find the value of the highest name, as before, and take parts of the given price for the lower names.

Rule 2. Consider the highest name as £'s, and annex, instead of the lower names, their value at the rate of £1 for one of the highest, and then take parts as before.

Ex.—Val. 14 cwt. 2 qr. 14 lb., at £4, 18s. 4d. per cwt.

			14	
	68	16	8	value of 14 cwt.
2 qr. = $\frac{1}{2}$ cwt.	2	9	2	〃 〃 2 qr.
14 lb. = $\frac{1}{4}$ of 2 qr.	0	12	$3\frac{1}{2}$	〃 〃 14 lb.

Value of 14 cwt. 2 qr. 14 lb. = £71, 18s. $1\frac{1}{2}$d. Ans.

Find the value of,

	cwt.	qr.	lb.		per cwt.		
1.	18	3	4	at	£3,	18s.	6d.
2.	20	3	0	〃	4	17	8
3.	16	0	22	〃	2	13	6
4.	15	3	18	〃	4	11	9
5.	6	2	7	〃	2	19	3
6.	7	3	18	〃	0	17	$6\frac{1}{2}$
7.	72	3	19	〃	3	17	4
8.	175	3	22	〃	0	18	8

	cwt.	qr.	lb.		per cwt.		
9.	16	2	0	at	£2,	6s.	11d.
10.	48	2	7	〃	74	16	6
11.	0	0	24	〃	4	17	0
12.	0	0	17	〃	3	5	4
13.	480	3	14	〃	0	6	8
14.	774	2	8	〃	3	2	6
15.	10	0	12	〃	1	9	6
16.	35	2	25	〃	3	7	11

	lb.	oz.	dwt.	gr.		per lb.		
17.	4	6	15	0	at	£4,	7s.	6d.
18.	2	1	4	18	〃	3	12	6
19.	18	1	16	5	〃	4	4	6
20.	42	11	0	0	〃	0	8	11
21.	39	10	13	12	〃	5	12	0
22.	86	3	15	0	〃	4	16	0
23.	54	7	16	0	〃	3	12	0
24.	72	11	10	0	〃	2	4	0
25.	65	10	14	0	〃	3	6	$8\frac{1}{3}$
26.	56	5	15	18	〃	4	3	4

	ac.	ro.	per.		per ac.		
27.	467	3	38	at	£2,	12s.	0d.
28.	96	2	24	〃	3	18	6
29.	12	3	20	〃	0	18	11
30.	15	2	18	〃	0	19	6

	ft.	in.		per ft.	
31.	424	7	at	6s.	$8\frac{1}{2}$d.
32.	96	10	〃	7	6
33.	465	6	〃	4	6
34.	167	3	〃	5	7
35.	878	9	〃	16	8

Note 1. It is often easier to consider the price as the quantity, and the quantity as the price.

Note 2. When the price of a lb. is given, the price of a cwt. may be found by multiplying 9s. 4d. (*i.e.* 112d.) by the pence, and 2s. 4d. (*i.e.* 112 far.) by the farthings in the price.

Find the value of,

1. 28 yds. at 57s.
2. 32 cwt. 〃 79s.
3. 16 cwt. 〃 94s.
4. 48 yds. at 37s.
5. 18 lb. 〃 19s.
6. 240 lb. 〃 29s.
7. 480 yds. at 43s.
8. 120 yds. 〃 £98.
9. 960 ac. 〃 £137.

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10. 1 cwt. at 7d. per lb.
11. 1 cwt. 〃 9½d. 〃
12. 1 cwt. 〃 11¼d. 〃
13. 1 cwt. 〃 5¾d. 〃
14. 3 cwt. 〃 4¼d. 〃
15. 7 cwt. at 9¾d. per lb.
16. 6 cwt. 〃 14½d. 〃
17. 11 cwt. 〃 13¾d. 〃
18. 12 cwt. 〃 10¼d. 〃
19. 14 cwt. 〃 11½d. 〃

PROMISCUOUS EXERCISES.

1. What cost 7846 yards, at 11½d. per yard?
2. What cost 8974 acres, at £4, 6s. per acre?
3. What cost 8345 yards of cloth, at 19s. 11d. per yard?
4. What cost 6748 yards of lawn, at 2s. 6d. per yard?
5. What cost 9674 yards of velvet, at 14s. 10d. per yard?
6. What cost 8341 acres, at £4, 12s. 8½d. per acre?
7. What cost 6834 hhds. of ale, at £3, 17s. 11d. per hhd.?
8. What cost 648 score of sheep, at £6, 11s. per score?
9. What cost 674 yards of fine cloth, at 18s. 11¼d. per yd.?
10. What cost 8341 yards of cotton, at 8¾d. per yard?
11. What cost 6874 sets of buckles, at 15s. 6d. per set?
12. What cost 9146⅓ bush. of wheat, at 15s. 6½d. per bush.?
13. What cost 3918 yards of cloth, at 12s. 6d. per yard?
14. Find the price of 272 lb., at $14\frac{6}{13}$d. per lb.
15. Find the weight of 8756572 sovereigns, each 5 dwt. $3\frac{3}{11}$ grs.
16 Required the tax on £576, 18s. 4d., at 7½d. per £1.
17. What cost 56 cwt. 18 lb. of tea, at £34, 12s. per cwt.?
18. What cost 37 cwt. 20 lb. 12 oz., at £3, 8s. per cwt.?
19. What cost 3 lb. 11 oz. 10 dwt., at £4, 12s. 6d. per lb.?
20. What cost 86 lb. 3 oz. 15 dwt. 18 gr. of silver plate, at £4, 16s. 4d. per lb.?
21. What cost 145 ac. 3 ro. 15 per. at £18, 6s. per acre?

22. What cost 95 ac. 2 ro., 18 per. of grass, at £37, 15s. 8d. per acre?
23. What cost 4571⅜ yards fine cloth, at 18s. 11¼d. per yd.?
24. A bankrupt's debts amount to £5670, 16s. 8d., and he compounds with his creditors for 17s. 6d. per £; required the amount of his assets.

BILLS OF PARCELS AND BILLS ON BOOK-DEBTS.

1. Mr JOHN ADAMS,

March 8, 1881. Bought of JAMES WILSON.

8 yards of silk,	at 13s. 8d.	per yd.
7 yards of satin,	at 12s. 10d.	〃
11 yards of brocade,	at 18s. 10¼d.	〃
12 yards of silk,	at 15s. 11d.	〃
9 yards of sarcenet,	at 4s. 3d.	〃
16 yards of velvet,	at 25s. 10d.	〃

Ans. £

2. Mr JOHN WILLS, Dr.

May 8, 1881. To HENRY SMITH.

To 9 pair stockings,	at 4s. 9d.	p. pair.
7 pair thread ditto,	at 3s. 5d.	〃
8 pair silk ditto,	at 13s. 10d.	〃
12 pair cotton ditto,	at 5s. 8d.	〃
18 yards fine flannel,	at 2s. 3d.	per yd.
27 ditto ditto,	at 1s. 9d.	〃

Ans. £

3. May 4, 1881. Mr John Vyse bought of John Laurie, 27 yards fine carpet, at 3s. 11d. per yard; 17 yards drugget, at 7s. 10d.; 19 yards scarlet, at 21s.; 13 yards broad cloth, at 17s. 11d.; 29 yards drab, at 13s. 9d.; 19 yards wax cloth, at 1s. 9d.

4. August 10, 1881. Mr Philip Norie bought of Peter Grant, 55 lb. of green tea, at 8s. 9d. per lb.; 71 lb. ditto, at 5s. 10d.; 89½ lb. bohea, at 6s. 4½d.; 18½ ditto, at 7s. 8d.; 74 lb. sugar, at 6¾d.; 11 sugar-loaves, each 15¼ lb., at 8¾d.

5. May 7, 1881. Mr James Scott bought of John Dun, 34 reams thick post, at 33s. per ream; 27 thin ditto, at 23s.; 16 ditto foolscap, at 19s.; 130 ditto printing demy,

at 15s. 6d.; 8 ditto superfine royal, at 43s.; 27 ditto cartridge, at 14s. 6d.; 7 cwt. pasteboard, at 17s. 6d. per cwt.

6. May 9, 1881. Mr F. Todd Dr. to George Grant. To 36 yards superfine cloth, at 22s. per yard; 5 pieces satin, each 20 yards, at 14s. 6d.; 7 pieces ditto, each 30 yards, at 12s. 3d.; 5 pieces glacé, each 18 yards, at 7s. 6d.; 28 yards silk, at 14s.; 3 pieces damask, each 30 yards, at 10s. 6d.; 53 yards silk, at 7s. 4d.

7. Edinburgh, September 3, 1881. Mr James Freeman bought of Simon Stewart, 40 pieces of calico, each 30 yards, at 2s. 4d. per yard; 21 pieces, each 27½ yards, at 3s. 8d.; 25 pieces, each 26 yards, at 2s. 7½d.; 16 pieces, each 25 yards, at 2s. 2½d.; 17 pieces, each 29 yards, at 2s. 3¼d.; 55 yards, at 4s. 2d.; 53 yards, at 7s. 6d.

8. 1881. March 11. Mr John Jolly bought of Samuel Todd, 34 pieces ginghams, each 37 yards, at 8½d. per yard; 49 pieces Irish linen, each 25 yards, at 1s. 7½d.; 33 pieces checks, each 30¾ yards, at 15d.; 62 pieces striped linen, each 25½ yards, at 4s. 6½d.; 20 pieces Holland, each 26 yards, at 2s. 8½d.; 34 pieces sheeting, each 64 yards, at 1s. 3¾d.; 27 pieces flowered cloth, each 39½ yards, at 3s. 10½d.

9. 1881. August 8. Mr Thomas Thomson bought of S. Walker, 57 yards cambrics, at 5s. 7¾d. per yard; 61 ditto, at 8s. 5¼d.; 79 English ells lawn, at 8s. 7½d. per yard; 107 Flemish ells lace, at 3s. 8¼d. per yard, 95 French ells lawn, at 15s. 7d. per yard; 56 yards linen, at 3s. 4½d.; 75 yards ditto, at 6s. 3¼d.; 98 yards cloth, at 17s. 8d.

10. 1881. April 4. Mr James Reid Dr. to Thomas Manners. To plain linen, 550 yards, at 2s. 8¾d. per yd.; striped ditto, 654 yds., at 2s. 8½d.; flowered ditto, 780 yds., at 13s. 4½d.; sprigged ditto, 660 yds., at 7s. 8¾d.; cambrics, 950 yds., at 7s. 8½d.; stripped ditto, 460 yds., at 13s. 4¼d.; flowered ditto, 468 yds., at 7s. 8½d.; silk gauzes, 860 yds., at 3s. 11¼d.

11. 1881. Nov. 30. Mr Joseph Smith bought of Mr John Whyte, 74 dozen pair men's shoes, at 47s. 3¾d. per dozen; 69 ditto, at 48s. 7½d.; 55 ditto slippers, at 57s. 6¼d.; 86 pair women's shoes, at 45s. 11¼d.; 98 ditto, at 48s. 6½d.; 79 ditto slippers, at 49s. 6¼d.; 107 pairs children's shoes, at 35s. 8½d.; 193 ditto slippers, at 39s. 10½d.

12. 1881. March 28. Mr Robert Rice bought of George

Price, 7 hhds. sugar, each 9 cwt. 3 qr. 27 lb., at 27s. per cwt.; 5 barrels raisins, each 2 cwt. 1 qr. 8 lb., at 35s.; 7 bags pepper, each 2½ cwt. 17 lb., at £7, 10s.; 5 casks prunes, each 35 cwt. 3 qr. 18 lb., at 24s.; 7 bags ginger, each 4 cwt. 3 qrs. 17 lb., at 35s.; 3½ butts currants, each 17 cwt. 2 qrs., at 47s.; 3 hhds. tobacco, each 3 cwt. 18 lb., at £25, 4s.; 7 canisters snuff, each 25½ lb., at £3, 14s. 8d.; 8 barrels rice, at 19s. per barrel; 7 bags clover-seed, each 250 lb., at 5½d. per lb.

13. 1881. March 19. Mr Richard Robins bought of James Niven, 5 boxes tea, each 3 cwt. 1 qr. 18 lb., at £39, 4s. per cwt.; 3 casks coffee, each 4 cwt. 3 qrs. 27 lb., at £29, 8s.; 67 cwt. 3 qrs. 26 lb. iron, at 16s. 8d.; 7 hhds. sugar, each 8 cwt. 27 lb., at £3, 6s. 8d.; 5 casks of old rum, each 84 gals., at 7s. 3½d. per gal.; 113½ gal. brandy, at 8s. 2½d.; 117 gal. gin, at 4s. 9d.; 57 cwt. 25 lb. raisins, at £6, 12s. 8d. per cwt.; 3 cwt. 17 lb. prunes, at 1s. 2d. per lb.; 118 lb. figs, at £2, 19s. 8d. per cwt.

14. 1881. January 8. Mr J. Campbell Dr. to William Currie. To 13 cwt. 1 qr. 14 lb. ginger, at £4, 13s. per cwt.; 7 cwt. 2 qrs. 27 lb. allspice, at £3, 18s.; 3 hhds. logwood, each 4 cwt. 3 qrs. 27 lb., at 14s. 6d.; 115 cwt. 1 qr. 19 lb. alum, at 18s. 4d.; 35 cwt. 27 lb. iron, at £17, 19s.; 375 qrs. 5 bush. corn, at 33s. 8d. per qr.; 15 lb. 3 oz. 20 grs. silver, at 5s. 2d. per oz.; 21 bags wool, each 196 lb., at 1s. 3d. per lb.; 4 hhds. linseed, at 57s. 6d. per hhd.; interest of £520 for fifteen months, at five per cent. per annum.

DECIMAL FRACTIONS.

A decimal fraction is one which has unity with a cipher or ciphers after it for its denominator, as $\frac{3}{10}$, $\frac{78}{1000}$, the unit being divided into 10, 100, 1000, etc., equal parts.

The numerator only is written, and must have as many places as there are ciphers in the denominator; but when it has not so many, ciphers are prefixed to it, in order to supply the deficient places, and a point is placed on the left to distinguish it from an integer.

The figure after the point is 10ths, the next 100ths, etc.; hence in decimals, as in integers, the digits increase in tenfold proportion from right to left: computations in decimals are therefore made as in integers, attention being paid to placing the point in its correct position.

A cipher on the left diminishes the value of the significant figures 10 times, but on the right it makes no alteration; thus, $\cdot 50 = \frac{50}{100} = \frac{5}{10}$; $\cdot 05 = \frac{5}{100}$.

Decimals are divided into terminate and interminate, for which see Problem I. of Reduction.

ADDITION AND SUBTRACTION OF FINITE DECIMALS.

Rule. Place the numbers so that the decimal points may be under each other; then proceed as in integers.

Ex.—Find the sum and difference of 5·723 and 3·8675.

$$\begin{array}{rr|rr} & 5{\cdot}723 & & 5{\cdot}723 \\ & 3{\cdot}8675 & & 3{\cdot}8675 \\ \hline \text{Sum,} & 9{\cdot}5905 & \text{Difference,} & 1{\cdot}8555 \end{array}$$

1. 478·63 + 89·005 + 5437·25 + ·000125 + 91·75 + 541·2375
2. 6·75 + 89·5 + ·00009 + ·502 + 7·548 + 2178
3. 51·416 + 915·13 + ·04751 + ·005819 + ·000045 + ·01018
4. 74·874 + 81·33486 + ·0974 + 1·0718 + 88·71034
5. 61·371568 + ·0091 + ·06371 + ·0008714 + 43·814
6. 75·67 + 125 + ·00725 + 67 + 19·25 + 37 + 2145·0007
7. 71·48 − 35·71; 87·31 − 6·871496; 3·187 − 1·00007; ·6748 − ·377; 1·000009 − ·784163; 4·001 − ·374; ·00078 − ·000089; 75 − ·0057; 67·525 − 5·0075

MULTIPLICATION OF FINITE DECIMALS.

Rule. Multiply as in integers, disregarding the points; then point off from the right of the product as many decimal places as there are in both factors; if the product has not so many, the deficiency must be supplied by *prefixing* ciphers to it.

Ex.—Multiply 7·856 by ·0008. **Ans.** ·0062848.

Having multiplied the factors; 7 figures are pointed off from the right of the product, since there are 3 decimal places in the one factor and 4 in the other.

$$\begin{array}{r} 7{\cdot}856 \\ {\cdot}0008 \\ \hline {\cdot}0062848 \end{array}$$

Note. To multiply by a unit with ciphers; remove the decimal point as many places towards the right as there are ciphers.

1. 74869·3×·673
2. 8914·714×6·7
3. 71·807×·0009
4. ·0714×·013
5. 91·07×·03
6. 58·62×·3
7. 74·58×·083
8. ·987×·642
9. ·078×·004
10. 478×·038
11. 748×·6, ·0075
12. 891×·72, 1·025
13. 78·14×10, 100
14. ·98516×10000
15. 6·87146×1000000

DIVISION OF FINITE DECIMALS.

Rule. Make the decimal places in the divisor and dividend the same, by annexing ciphers to that which has the least number; then divide as in integers, and to continue the quotient annex ciphers to the remainder: the number of ciphers last annexed is the number of places to point off, from the right of the quotient.

Note. To divide by a unit with ciphers, remove the decimal point as many places towards the left as there are ciphers.

Ex. Divide 124·65625 by 1·25. **Ans.** 99·725.

125000)12465625·000
99·725

Three ciphers are here annexed to the divisor to make the number of places the same as in the dividend; then dividing 12465625 by 125000, 99 is obtained, and to carry on the quotient *three* ciphers are annexed to the remainders, when the division terminates, and therefore *three* figures are pointed off from the right of the quotient.

1. 1·4641÷·11, 1·936
2. ·504020944÷·8204, ·064
3. 1836·88305÷23·15, ·025
4. 22118·6052122÷53·146
5. ·04888501956÷·01548
6. ·0030266061236÷·8416591
7. 784689·5÷·25
8. 87486·125÷·75
9. ·8741685÷·00785
10. 37416·556÷33·85
11. 18÷·785, ·00045
12. 7486·35÷1000
13. (17·9435 — 4·9646) × 4·62 ÷ ·363

REDUCTION OF FINITE DECIMALS.

Problem I. To reduce a vulgar fraction to a decimal.

Rule. Divide the numerator, with ciphers annexed to it, by the denominator; then point off as many places from the right of the quotient as the ciphers used in the dividend.

NOTE. If the division terminates, the decimal is said to be *finite* or *terminate;* if not, it is called *interminate.*

An interminate decimal is called a *repeater*, when the same figure is constantly repeated; a *circulate*, when several recur in their order, and a point is placed above the repeater or above the first and last figures of the circulate, as $\frac{4}{7} = \cdot\dot{5}7142\dot{8}$. The repeater or circulate is said to be *pure*, when the repeating figures begin at the decimal point; *mixed*, when there are other figures before them, as $\frac{4}{11} = \cdot\dot{3}\dot{6}$; $\frac{5}{6} = \cdot 8\dot{3}$.

EX.—Reduce $\frac{1}{80}$ to a decimal. ANS. ·0125.

Having annexed *four* ciphers to the numerator, *four* figures are pointed off from the right of the quotient for the decimal.

80)1·0000
·0125

Reduce to decimals,

1. $\frac{3}{8}$
2. $\frac{1}{2}$
3. $\frac{1}{4}$
4. $\frac{3}{4}$
5. $\frac{7}{8}$
6. $\frac{1}{3}$
7. $\frac{1}{9}$
8. $\frac{5}{6}$
9. $\frac{1}{6}$
10. $\frac{9}{16}$
11. $\frac{1}{5}$
12. $\frac{1}{75}$
13. $\frac{1}{1875}$
14. $\frac{7}{11}$
15. $\frac{8}{11}$
16. $\frac{4}{9}$
17. $\frac{9}{11}$
18. $\frac{1}{7}$
19. $\frac{3}{11}$
20. $\frac{1}{13}$
21. $\frac{1}{99}$
22. $\frac{11}{54}$
23. $\frac{2}{3}$
24. $\frac{16}{17}$

PROB. II. To reduce a finite decimal to a vulgar fraction.

RULE. Make the given decimal the numerator, and unity, with as many ciphers annexed to it as there are figures in the decimal, the denominator; then reduce the fraction to its lowest terms.

EX.—Reduce ·025 to a vulgar fraction. ANS. $\frac{1}{40}$.

Here, $\cdot 025 = \frac{0}{10} + \frac{2}{100} + \frac{5}{1000} = \frac{25}{1000} = \frac{1}{40}$.

Reduce to vulgar fractions,

1. ·5
2. ·25
3. ·75
4. ·125
5. ·625
6. ·34
7. ·375
8. ·005
9. ·078
10. ·15625
11. ·03125
12. ·01875
13. 3·24
14. 5·128
15. 7·512
16. 6·075
17. ·00525
18. ·015625
19. ·078125
20. ·006225

PROB. III. To reduce a compound quantity to the decimal of a higher name.

RULE. Reduce the quantity to the fraction of the required name by Prob. VI., p. 60; then reduce the fraction to its equivalent decimal.

EX.—Reduce 15s. 9d. to the decimal of £1. ANS. £·7875.

Here, 15s. 9d. = 189d., and 189d. = £$\frac{189}{240}$ = £·7875.

Reduce,			Reduce,		
1. 9d. to the dec. of		£1	21. 10 oz. 12 dr. to dec. of		a lb.
2. 10d.	〃	£1	22. 3 oz. 14 dwt. 8 g.	〃	lb.
3. 17s. 6d.	〃	£1	23. 3 qrs.	〃	yd.
4. 12s. 8¼d.	〃	£1	24. 1 qr. 2 nl.	〃	yd.
5. 19s. 11¾d.	〃	£1	25. 6 fur. 5 poles	〃	ml.
6. 14s. 3½d.	〃	£1	26. 2 ro. 11 per.	〃	ac.
7. 3s. 4d.	〃	£1	27. 10 in. 8 parts	〃	ft.
8. 6s. 8d.	〃	£1	28. 11d.	〃	sh.
9. 13s. 4d.	〃	£1	29. 10d.	〃	sh.
10. 11d.	〃	£1	30. 7½d.	〃	sh.
11. 4½d.	〃	£1	31. 12s. 4¾d.	〃	gu.
12. ¾d.	〃	£1	32. 4 bu. 3 pk. 1¼ ga.	〃	qr.
13. 7 lb.	〃	a cwt.	33. 5 yd. 2 ft. 11 in.	〃	po.
14. 8 lb.	〃	cwt.	34. 7 days 6 ho.	〃	ye.
15. 17 lb.	〃	ton	35. 7 ho. 9 min.	〃	day
16. 18 cwt. 13 lb.	〃	ton	36. 22 min. 3 sec.	〃	ho.
17. 11 oz. 17 dwt.	〃	lb.	37. 1 ro. 22 per.	〃	ac.
18. 13 dwt. 16 gr.	〃	lb.	38. 20 per. 8 yd.	〃	ac.
19. 5 dwt. 12 gr.	〃	oz.	39. 18 yd. 4 ft.	〃	ro.
20. 7 oz. 14 dr.	〃	cwt.	40. 3 days 12 ho.	〃	ye.

Prob. IV. To find the value of a finite decimal in lower names.

Rule. Multiply by the number of the next lower name contained in that given, and point off as many figures from the right of the product as are in the given decimal; reduce the figures pointed off into the next lower name, and point off as before, and so on; the figures on the left of the points are integers of the various names.

Ex.—Find the value of 1·3125 ac. Ans. 1ac. 1ro. 10per.

Here, ·3125 ac. × 4 = 1·25 ro. and ·25 ro. × 40 = 10 per.; the result is therefore 1 ac. 1 ro. 10 per.

$$\begin{array}{l} 1{\cdot}3125 \text{ ac.} \times 4 \\ 1{\cdot}\overline{2500} \text{ ro.} \times 40 \\ 10{\cdot}\overline{0000} \text{ per.} \end{array}$$

Find the value of,

1. £·0375
2. £·0416
3. £·875
4. £·634375
5. £·9989583
6. £·714583
7. £·16
8. £·3
9. £·6
10. £·04583
11. £·01875
12. £·003125

Find the value of,

13. ·0625 cwt.
14. ·071428 cwt.
15. ·007589 ton.
16. ·9058 ton.
17. ·9875 lb. tr.
18. ·05694 lb.
19. ·275 oz. tr.
20. ·004394 cwt.
21. ·671875 lb. av.
22. ·30972 lb. tr.
23. ·75 yard.
24. ·375 yard.
25. ·765625 mile.
26. ·56875 acre.
27. ·8 foot.
28. ·916 sh.
29. ·83 sh.
30. ·625 sh.
31. ·59027 gu.
32. ·61328125 qr.
33. 1·085 pole.
34. ·019863 year.
35. ·2979 day.
36. ·3675 hour.

CONTRACTIONS IN DECIMALS.

In the application of decimals to practical purposes, it is generally sufficient to secure three or four places in the results; to effect this, one place more in each is retained than is required, and if the nearest rejected figure is 5, or higher, the last retained figure is increased by 1: these decimals are added and subtracted in the usual way.

1. To multiply, so as to retain a certain number of decimal places in the product.

Rule. Place the units figure of the multiplier below that place of decimals in the multiplicand which corresponds with the number to be retained in the answer, and write the other figures in inverted order; next multiply by each figure of the multiplier, beginning with the figure directly above it, including the carriage from the rejected figures, viz., 1 from 5 to 15, 2 from 15 to 25, 3 from 25 to 35; also place the products, so that their right-hand figures shall stand under each other, then add them, and point off the required number of decimal places.

Ex.—Mult. 3·1416 by ·675, retaining 4 decimal places.
Ans. 2·1206.

Here, 0 the *units* figure of the multiplier is placed below 6, the fourth place of decimals in the multiplicand, and the other figures 675 are placed before 0 in inverted order; then 6 × 1 are 6, and the carriage from 6 times 6 being 4, 6 + 4 = 10, 0 is therefore placed below and 1 carried, etc.; ain 7 × 4 = 28, and the carriage from 7 × 1 ng 1, 28 + 1 = 29, etc.

$$\begin{array}{r} 3{\cdot}1416 \\ \underline{5760} \\ 18850 \\ 2199 \\ \underline{157} \\ 2{\cdot}1206 \end{array}$$

1. Multiply ·874 by ·375, retaining 4 decimal places.
2. 〃 ·879 by 4·21, retaining 3 〃
3. 〃 6·714 by ·4678, retaining 4 〃
4. 〃 4·8752 by 6·879, retaining 5 〃
5. 〃 71·8563 by ·00725, retaining 6 〃
6. 〃 ·04765 by 7·829, retaining 6 〃

2. To divide, so as to retain a certain number of decimal places in the quotient.

Rule. Point off from the left of the divisor as many figures as are to be in the *whole* quotient; having obtained the first figure of the quotient, for each after figure divide the last remainder, omitting a figure at each step on the right of those retained in the divisor, but include the carriage from those rejected as in the last contraction: then point off from the right of the quotient as many decimal places as were to be retained.

Ex.—Divide 73·1567 by 21·7356, retaining 3 decimal places. Ans. 3·365.

Here, four figures are pointed off from the left of the divisor, since the quotient will contain *one* integer figure and *three* decimal figures.

```
21·73,56) 73·1567 ( 3·365
   · · ·   6521
           ----
            794
            652
            ---
            142
            130
            ---
             12
             11
             --
```

1. Divide ·5789648 by ·2465, retaining *four* decimal places.
2. 〃 ·9146856 by ·4873, retaining *four* 〃
3. 〃 6·8964896 by ·6738, retaining *three* 〃
4. 〃 8·7468678 by ·3785, retaining *four* 〃
5. 〃 ·00735 by ·04687, retaining *five* 〃
6. 〃 12·84759 by ·006875, retaining *three* 〃

3. To reduce shillings, pence, and farthings, to decimals of £1 mentally.

Rule. One half of the shillings gives the first decimal place; the farthings in the remainder, increased by their *twenty-fourth* part, give the next two places. Again, subtract 25, 50, or 75, from the last two figur multiply the remainder by 4, and increase the product by its *twenty-fourth* part for the next two places; proceed in the same way to obtain other two places.

Ex.—Reduce 19s. 7½d. to the decimal of £1 mentally.
Ans. £·98125.

Here, 19s. ÷ 2 = £·9, and 1s. 7½d. = 78f. over; 78f. + $\frac{1}{24}$ of 78 = £·081; again, 81 − 75 = 6, and 6 × 4 + $\frac{1}{24}$ of 24 = £·00025: hence, 19s. 7½d. = £·98125.

Reduce to decimals of £1 mentally,

1. 8s. 8½d.
2. 7 4¼
3. 9 6¾
4. 14s. 8¼d.
5. 13 5½
6. 17 9¾
7. £4, 10s. 6d.
8. 3 8 7
9. 4 6 8½
10. £7, 15s. 8¾d.
11. 2 13 1⅓
12. 3 16 8¼

4. To value decimals of £1 mentally.

Rule. Double the first decimal place for shillings, but when the second is 5 or upwards, add 1 thereto; then divide the second and third places, or their excess above 50 by 4, first deducting their *twenty-fifth* part; the quotient is pence, and the remainder farthings.

Ex.—Value £·875 mentally. Ans. 17s. 6d.

Here, £·8 × 2 = 16s., and 16s. + 1s. (since 7 is more than 5) = 17s.; also 75 − 50 = 25 and 25 − $\frac{1}{25}$ of 25 = 24 f. = 6d.; hence, £·875 = 17s. 6d.

Find mentally the value of,

1. £·448
2. ·325
3. 2·536
4. £·678
5. ·904
6. ·817
7. £4·981
8. 6·743
9. 4·998
10. £·799
11. ·867
12. ·874
13. £4·8253
14. 6·9778
15. 9·4687

EXERCISES IN FINITE DECIMALS.

1. What cost 22½ cwt. sugar, at £4$\frac{5}{16}$ per cwt.?

2. What is the weight of 15⅔ hhds. tobacco, each 18⅝ cwt.?

3. What is the difference between 12⅝ gallons, and $\frac{23}{30}$ of $\frac{11}{16}$ of a quarter?

4. A person who had ¾ of a ship, sold ⅜ of his share; what part had he remaining?

ce £10, 7s. 1$\frac{7}{20}$d. to the dec. of £19, 14s. 6d.

e £79$\frac{5}{32}$ among 7 men and 5 boys, so that each

ave ⅗ of a man's share.

7. Bought $18\frac{5}{8}$ cwt. sugar, at £$4\frac{1}{5}$ per cwt., and sold it at $11\frac{3}{4}$d. per lb.; what was gained or lost on it?

8. Find the interest of £$456\frac{7}{8}$ for $4\frac{5}{8}$ years, at $4\frac{1}{4}$ per cent.

9. What will $18\frac{5}{8}$ yards of cloth cost, at the rate of $3\frac{1}{2}$ yards for £$1\frac{4}{5}$?

10. Distributed £37, 6s. 2d. among some indigent people, and gave each $6\frac{1}{8}$s.; how many poor were there?

11. Mult. ·00075 by ·00673 and divide 441·5 by ·000083.

12. Reduce 7 cwt. 3 qr. 14 lb. to the decimal of 15 cwt.

13. Borrowed £$\frac{7}{8}$ and paid $\frac{2}{5}$ gu.; how much is still due?

INTERMINATE DECIMALS.

REDUCTION OF INTERMINATE DECIMALS.

Problem I. To reduce a *pure* repeating or circulating decimal to a vulgar fraction.

Rule. Make the repeater or circulate the numerator, and for the denominator place as many *nines* as there are recurring figures.

Ex.—Reduce $\cdot\dot{0}4\dot{5}$ to a vulgar fraction. **Ans.** $\frac{5}{111}$.

Here, $\cdot\dot{0}4\dot{5} = \frac{45}{999} = \frac{5}{111}$

Reduce to vulgar fractions,

$\cdot\dot{7}$; $\cdot\dot{3}$; $\cdot\dot{6}$; $\cdot\dot{2}\dot{7}$; $\cdot\dot{5}\dot{4}$; $\cdot\dot{0}6\dot{3}$; $\cdot\dot{1}8\dot{5}$; $\cdot\dot{0}7\dot{4}$; $\cdot\dot{9}6\dot{2}$; $\cdot\dot{4}2857\dot{1}$;
$\cdot\dot{0}08\dot{1}$; $\cdot\dot{6}1538\dot{4}$; $\cdot\dot{0}9523\dot{8}$; $\cdot\dot{5}7142\dot{8}$; $\cdot\dot{7}2\dot{9}$; $\cdot\dot{3}7\dot{2}$; $\cdot\dot{2}2\dot{5}$.

Prob. II. To reduce a *mixed* repeating or circulating decimal to a vulgar fraction.

Rule. For the numerator, subtract the finite part from the whole; and for the denominator place a *nine* for each repeating figure, with a cipher annexed for each finite figure.

Ex.—Reduce $\cdot 04\dot{7}\dot{2}$ to a vulgar fraction. **Ans.** $\frac{13}{275}$.

Here, $\cdot 04\dot{7}\dot{2} = \frac{472-4}{9900} = \frac{468}{9900} = \frac{13}{275}$

Reduce to vulgar fractions,

$\cdot 58\dot{3}$; $\cdot 29\dot{5}\dot{4}$; $\cdot 1\dot{6}$; $\cdot 0\dot{4}\dot{5}$; $\cdot 65\dot{2}9\dot{6}$; $\cdot 00\dot{6}$; $\cdot 63\dot{7}2\dot{9}$; $\cdot 01\dot{4}87\dot{3}$;
$\cdot 8\dot{3}$; $\cdot 14\dot{9}$; $\cdot 57\dot{6}3\dot{9}$; $\cdot 00\dot{5}7\dot{6}$; $\cdot 094\dot{8}91\dot{0}$; $\cdot 000\dot{2}5\dot{9}$; $\cdot 3\dot{3}7\dot{8}$

Prob. III. To make circulates similar.

Rule. Extend each of them as many places beyond the longest finite part, as is denoted by the least common multiple of the number of figures in the several circles.

Ex.—Make $\cdot 0\dot{3}\dot{7}$, $\cdot 42\dot{8}7\dot{5}$, $\cdot 008\dot{3}$ similar.

Here, the L. C. M. of 2, 3 and 1, the places in the several circles is 6, and 3 is the longest finite part; each decimal is therefore extended 9 places from the decimal point.

$\cdot 037\dot{3}7373\dot{7}$

$\cdot 428\dot{7}5875\dot{8}$

$\cdot 008\dot{3}3333\dot{3}$

Make the following circulates similar,

1. $\cdot\dot{3}\dot{6}$, $\cdot\dot{4}6\dot{8}$
2. $\cdot 0\dot{4}\dot{2}$, $\cdot\dot{1}45\dot{9}$
3. $\cdot 00\dot{7}\dot{6}$, $\cdot\dot{1}3\dot{7}$
4. $\cdot\dot{3}$, $\cdot 26\dot{4}1\dot{8}$, $\dot{4}0\dot{5}$
5. $\cdot 4\dot{8}5\dot{4}$, $\cdot 762\dot{9}2\dot{7}$
6. $\cdot 1\dot{5}3\dot{6}$, $\cdot 0\dot{7}$, $\cdot 0\dot{0}\dot{2}$
7. $1\cdot\dot{4}\dot{2}$, $\cdot 000\dot{7}$, $\cdot\dot{1}4\dot{5}9\dot{2}$
8. $\cdot 00\dot{4}$, $\cdot\dot{2}45\dot{9}$, $\cdot 1\dot{6}8\dot{7}$
9. $\cdot\dot{1}2\dot{9}$, $\cdot\dot{0}40\dot{1}$, $1\cdot 0\dot{3}$

ADDITION AND SUBTRACTION OF INTERMINATE DECIMALS.

Case I. When the decimals are repeaters only.

Rule. Extend each, *one* place beyond the longest finite part, and carry or borrow at 9 upon the right.

Ex.—Find the sum and difference of $14\cdot 72\dot{3}$ and $9\cdot 6873\dot{8}$.

$$\begin{array}{rr} & 14\cdot 7233\dot{3} \\ & 9\cdot 6873\dot{8} \\ \hline \text{Sum,} & 24\cdot 4107\dot{2} \end{array} \qquad \begin{array}{rr} & 14\cdot 7233\dot{3} \\ & 9\cdot 6873\dot{8} \\ \hline \text{Difference,} & 5\cdot 0359\dot{4} \end{array}$$

1. $7\cdot 02\dot{3}+\cdot\dot{6}+\cdot 52\dot{5}+\cdot 008\dot{7}$
2. $6\cdot\dot{3}+\cdot 06\dot{7}+\cdot 14\dot{3}+\cdot 08\dot{4}$
3. $8\cdot 009\dot{4}+\cdot\dot{4}+\cdot 0\dot{6}+\cdot 00\dot{7}$
4. $\cdot 381\dot{3}+\cdot 4\dot{2}+\cdot 521\dot{6}+\cdot 9472\dot{4}$
5. $15\frac{1}{3}+34\frac{1}{4}+\frac{7}{18}+16\frac{5}{6}+\frac{11}{24}+7\frac{1}{9}$
6. $17\frac{5}{12}+6\frac{1}{2}+16\frac{1}{3}+12\frac{1}{25}+\frac{7}{400}$
7. £3, 6s. 8d.+£7, 19s. 11d.+£10, 12s. 6½d.+19s. 6d.+£5⅜
8. $\cdot 71458\dot{3}-\cdot 6343\dot{7}5$
9. $\cdot 525-\cdot\dot{3}$
10. $14\cdot 68\dot{4}-2\cdot 798\dot{6}$
11. $12\frac{1}{6}-7\frac{3}{8}$
12. $16\frac{5}{12}-7\frac{5}{6}$
13. $21\cdot 0\dot{3}-\cdot 968\dot{2}$
14. $\cdot 998958\dot{3}-\cdot 0291\dot{6}$
15. £4, 5s. 8d.—£2, 12s. 4d.
16. 14lb. 16gr.—5 oz. 22 gr.
17. 21 da. 7 ho.—12 da. 16 ho.

Case II. When the decimals are circulates.

Rule. Make them similar, and add the carriage (if any) from the left of the circle, to the right hand figure of the lower circle before adding or subtracting.

Ex.—Find the sum and diff. of $21{\cdot}867\dot{2}\dot{7}$ and $1{\cdot}297\dot{8}4\dot{6}$.

$$\begin{array}{rr|rr} & 21{\cdot}867\dot{2}72727\dot{7} & & 21{\cdot}867\dot{2}72727\dot{7} \\ & \underline{1{\cdot}297\dot{8}46846\dot{6}} & & \underline{1{\cdot}297\dot{8}46846\dot{6}} \\ \text{Sum,} & 23{\cdot}165\dot{1}1957\dot{4} & \text{Difference,} & 20{\cdot}569\dot{4}2588\dot{0} \end{array}$$

1. $\cdot 7\dot{1}5\dot{4} + \cdot 3\dot{1}5\dot{3} + \cdot 872\dot{4}23\dot{9}$
2. $\cdot 792\dot{6}73\dot{2} + \cdot\dot{3} + \cdot 51\dot{6} + \cdot\dot{4}0\dot{5}$
3. $\frac{3}{7} + \frac{6}{7} + \frac{6}{11} + \frac{10}{27} + \frac{13}{37}$
4. $\cdot 0\dot{7}2\dot{9} + \cdot 00\dot{3} + \cdot\dot{1}4285\dot{7} + \cdot\dot{4}\dot{5}$
5. $7{\cdot}6\dot{3} + \cdot 0\dot{4}\dot{5} + \cdot\dot{7}29\dot{5} + \cdot 00\dot{4}$
6. $\frac{49}{52} + \frac{278}{390} + \frac{1}{3} + \frac{5}{6} + \frac{7}{12}$
7. 17 ml. 344 yd. + 16 ml. 890 yd. + 14 ml. 750 yd.
8. $\cdot\dot{6}42857\dot{1} - \cdot 17\dot{8}5714\dot{2}$
9. $\cdot 0\dot{1}5384\dot{6} - \cdot 006\dot{3}\dot{5}$
10. $\frac{13}{14} - \frac{2}{3}$
11. $18\frac{1}{12} - 4\frac{5}{14}$
12. $7\frac{2}{3} - 3\frac{6}{13}$
13. $11\frac{10}{27} - 5\frac{23}{37}$.

MULTIPLICATION OF INTERMINATE DECIMALS.

Case I. When one of the factors is a repeater.

Rule. Multiply by the other factor, carrying at 9 on the right; and extend the several products the same length before adding.

Case II. When one of the factors is a circulate.

Rule. Multiply by the other factor, adding the carriage from the left of the circle to the right of the product; and make the circles similar before adding.

Ex.—$21{\cdot}875\dot{6} \times 4{\cdot}7$; and $19{\cdot}8\dot{7}5\dot{4} \times 58$.

$$\begin{array}{rr|rr} (1.) & 21{\cdot}875\dot{6} & (2.) & 19{\cdot}8\dot{7}5\dot{4} \\ & \underline{4{\cdot}7} & & \underline{\cdot 58} \\ & 153129\dot{6} & & 15900\dot{3}\dot{8} \\ & \underline{875026\dot{6}} & & \underline{99377\dot{3}\dot{7}} \\ \text{Product,} & \underline{\underline{102{\cdot}8156\dot{3}}} & \text{Product,} & \underline{\underline{11{\cdot}5277\dot{7}\dot{5}}} \end{array}$$

Case III. When both factors are interminate.

Rule. Reduce one of them to a vulgar fraction, then multiply the other by the numerator, and divide the product by the denominator, annexing the repeating figures in their order to carry on the division.

Note. To multiply by $\cdot\dot{3}$, take $\frac{1}{3}$ of the multiplicand; and to multiply by $\cdot\dot{6}$, subtract $\frac{1}{3}$ of the multiplicand from itself.

1. $\cdot 1\dot{6} \times 7$
2. $27\cdot 08\dot{3} \times 9$
3. $\cdot 40\dot{6} \times 52$
4. $27\cdot 88\dot{3} \times 8\cdot 75$
5. $79\cdot\dot{6} \times 50$
6. $84\cdot\dot{7} \times 8000$
7. $\frac{13}{27} \times 7$
8. $7\frac{14}{27} \times \cdot 05$
9. $\frac{6}{11} \times 20$
10. $4\cdot 3\frac{4}{7} \times 600$
11. $86\cdot 53\frac{8}{37} \times 58\frac{3}{4}$
12. $\frac{5}{14} \times \frac{11}{16}$

13. $\cdot 625 \times \cdot\dot{3}$
14. $87\cdot\dot{2} \times \cdot 0\dot{7}$
15. $\cdot 845 \times \cdot 4\dot{8}$
16. $87\cdot 34 \times 2\cdot 6\dot{7}$
17. $\cdot 62\dot{3} \times \cdot 0\dot{6}$
18. $\cdot\dot{3}0\dot{9} \times \cdot 4\dot{6}$
19. $\cdot 825 \times \cdot\dot{3}\dot{6}$
20. $64\cdot 35 \times \cdot 7\dot{7}\dot{2}$
21. $16\cdot\dot{1}4\dot{5} \times \cdot 5\dot{7}2\dot{9}$
22. $\cdot 7\dot{2}1\dot{6} \times \cdot\dot{5}\dot{4}$
23. $\cdot 94\dot{3} \times \cdot 2\dot{1}7\dot{2}$
24. $\cdot 6\dot{3}5 \times 9\cdot\dot{4}8\dot{1}$
25. $67\frac{11}{18} \times \frac{3}{8}$
26. $8\frac{11}{37} \times \frac{13}{22}$
27. $3\frac{5}{13} \times \frac{5}{6}$ of $\frac{7}{9}$
28. $6\frac{2}{27} \times 4\frac{3}{37}$
29. $8\frac{1}{12} \times \frac{4}{5}$ of $\frac{5}{6}$
30. $\frac{21}{77} \times \frac{43}{45}$

DIVISION OF INTERMINATE DECIMALS.

Case I. When the dividend only is interminate.

Rule. Divide as in finite decimals, but annex the repeating figures in their order instead of ciphers, to carry on the division.

Ex.—Divide $27\cdot 86\dot{5}\dot{4}$ by 8. **Ans.** $3\cdot 483\dot{1}\dot{8}$

Here, $27\cdot 8654\dot{5}\dot{4} \div 8 = 3\cdot 483\dot{1}\dot{8}1$.

Case II. When the divisor is interminate.

Rule. Reduce it to a vulgar fraction; then multiply by the denominator, and divide by the numerator.

Note. To divide by $\cdot\dot{3}$, multiply by 3; and to divide by $\cdot\dot{6}$, add $\frac{1}{2}$ of the dividend to itself.

1. $5\cdot 1\dot{6} \div 4$
2. $3\cdot\dot{3}7\dot{0} \div 7$
3. $4\cdot 1966\dot{2} \div 37$
4. $73\cdot 41\dot{6} \div 6\cdot 25$
5. $15\cdot 0\dot{6} \div 1\cdot 5$
6. $169\cdot\dot{3} \div \cdot 05$
7. $75\cdot 2\dot{6} \div \cdot 5$
8. $\cdot 1134 \div \cdot\dot{7}$
9. $23\cdot 5 \div \cdot\dot{4}$
10. $8\cdot\dot{9}6\dot{2} \div \cdot\dot{3}$
11. $363\cdot 5\dot{4}0\dot{7} \div 48\cdot\dot{3}$
12. $9 \div \cdot\dot{4}\dot{5}$
13. $\cdot 12693 \div 19\cdot\dot{3}\dot{9}$
14. $17\cdot\dot{4}\dot{5} \div \cdot\dot{8}\dot{4}$
15. $\cdot 3\dot{4}7\dot{4} \div \cdot\dot{6}$
16. $\cdot 24835 \div \cdot\dot{2}9\dot{6}$
17. $\frac{5}{6}$ of $\frac{11}{12} \div 7\frac{1}{7}$
18. $\frac{2}{3}$ of $\frac{13}{37} \div \frac{5}{23}$

EXERCISES IN DECIMAL FRACTIONS.

1. From $\frac{1}{3}$ of $\frac{1}{4}$ cwt. take $\frac{1}{5}$ of $\frac{1}{8}$ lb.

2. Bought $\frac{1}{5}$ of a vessel, and sold $\frac{3}{4}$ of my share; what share of it have I retained?

3. Bought $78\frac{5}{8}$ yards cloth, at £$\frac{5}{6}$ per yard, and sold it at £$\frac{7}{8}$; what did I gain?

4. What cost $67\frac{11}{12}$ lb. sugar, at £$4\frac{5}{12}$ per cwt.?

5. If $493\frac{1}{2}$ gal. rum cost £$422\frac{5}{11}$; what is that per gal.?

6. A man distributed £$\frac{11}{12}$ among 7 poor people; how much did each receive?

7. Value £$\cdot 88\dot{3}$; $\cdot 568\dot{6}$ cr.; $\cdot 372\dot{5}$ cwt.; $\cdot 674\dot{2}$ ml.; $\cdot 58\dot{3}$ gu.

8. Value $\cdot 67\dot{4}\dot{5}$ gu.; $\cdot 419\dot{6}4\dot{4}$ cwt.; £$\cdot 75\dot{3}0\dot{7}$; $\cdot 8\dot{4}72\dot{5}$ ac.

9. Required the commission on £$57\frac{11}{14}$, at $\frac{5}{12}$ per cent.

10. If $5\frac{1}{2}$ cwt. be carried $19\frac{1}{3}$ miles for £$\frac{5}{6}$; how far should $17\frac{3}{8}$ cwt. be carried for £$2\frac{6}{7}$?

11. If $\frac{3}{8}$ of a ship cost £$240\frac{1}{8}$; what will $\frac{6}{7}$ of it cost?

12. What is the interest of £83, 13s. 8d. for $\frac{5}{18}$ year, at $4\frac{5}{8}$ per cent.?

13. Value $\cdot 78\dot{3}$ lb. $+ \cdot 72\dot{4}$ oz. $+ \cdot 87\dot{5}$ dwt. $- \cdot 98\dot{4}$ gr.

14. The ratio of the circumference of a circle to its diameter is 3·14159 : 1; required the diameter of the earth, its circumference being 24899·06738534 miles.

15. Reduce 3 qrs. 16 lb. to the dec. of 14 cwt. 1 qr. 4 lb.

16. Mult. ·06704 by ·000576, and divide 172·8 by ·0008.

17. Find the value of £275, 3s. 4d. — £179, 16s. 8d.

18. Find the value of $\cdot 8\dot{3}$ of £5, 7s. 9d. $+ \cdot\dot{4}\dot{5}$ of £7, 14s. 11d. $+ \cdot 58\dot{3}$ of £6, 19s. 6d. $- \cdot 75$ of $5\frac{1}{2}$ gu.

19. The diameter of the planet Jupiter being 87000 miles; what is its circumference?

20. £6700 is divided among two families, one of which, consisting of 7 persons, gets $\frac{3}{8}$ of it, and the other, consisting of 9 persons, gets the rest; how much did each person get?

21. Divide £$457\frac{5}{8}$ among 4 men and 3 boys, giving each of the boys $\frac{5}{8}$ of a man's share.

22. What sum must be put to interest now at $4\frac{1}{2}$ per cent., that the interest may pay a debt of £$29\frac{3}{4}$, due $1\frac{1}{8}$ year hence?

23. A cistern has 2 pipes, the first of which will empty

it in 20 hours,' and the other in 30 hours; in what time would it be emptied if both were left open, supposing the current to be always alike?

24. If $\frac{3}{4}$ of a yard of cloth, which is $\frac{4}{5}$ English ell broad, costs 15s. 5d.; what will $17\frac{1}{3}$ yards, $\frac{7}{8}$ yard broad cost?

25. How many yards of paper $\frac{5}{8}$ yard broad will line a room $19\frac{7}{12}$ feet long, $15\frac{5}{8}$ feet wide, and $9\frac{1}{3}$ feet high?

NOTE. Several pages are devoted at the end of this work to the proposed *Decimal Coinage.*

ALLOWANCES ON GOODS

ARE certain deductions allowed by the wholesale merchant to the purchaser on various accounts.

Gross weight is the weight of both goods and packages.

Tare is an allowance granted to the purchaser for the weight of the chest, barrel, &c., containing the goods: after it is deducted the remainder is called the *tare suttle.*

Tret is an allowance of 4 lb. on 104 lb., given on goods liable to waste, and is deducted from the tare suttle; it is now nearly discontinued, or allowed for in the price: after it is deducted, the remainder is called the *tret suttle.*

Draft is allowed on some goods, for loss by selling them in small quantities: it is deducted before the tare.

After every allowance is deducted, the remainder is called the *net weight.*

CASE I. When the allowance is at a given rate per chest, barrel, &c.

RULE. Multiply the rate by the number of chests, &c.

CASE II. When it is at a given rate per cwt.

RULE. Multiply by the rate and divide by 112, or take the same parts of the quantity that the rate is of a cwt.

EX.—What is the net weight of 468 cwt., deducting tare at 16 lb. per cwt., and tret 4 lb. on 104 lb.?

16 lb. = $\frac{1}{7}$ cwt.)	468	cwt.	0	qr.	0	lb.	gross weight.
	66	"	3	"	12		tare.
4 lb. on 104 lb. = $\frac{1}{26}$)	401	"	0	"	16		tare suttle.
	15	"	1	"	20		tret.
Net weight,	385	cwt.	2	qr.	24	lb.	tret suttle.

1. What is the tare on 58 casks of sugar, at 23 lb. per cask?

2. What is the net weight of 33 hhds. sugar, each 19 cwt. 3 qr. 16 lb., tare at 26 lb. per hhd.?

3. What is the net weight of 42 hhds., each 32 cwt. 1 qr. 19 lb., tare at 37 lb. per hhd.?

4. What is the net weight of 37 barrels of figs, each 3 cwt. 1 qr. 18 lb., tare at 34 lb. per barrel?

5. What is the net weight of 93 hhds. tobacco, each 17 cwt. 2 qr. 24 lb., tare at 38 lb. per hhd.?

6. What is the net weight of 39 chests of tea, each 3 qr. 27 lb., tare at 21 lb. per chest?

7. What is the net weight of 468 cwt. 3 qr. 16 lb., tare 14 lb. per cwt.?

8. What is the net weight of 315 cwt. 2 qr. 21 lb., tare 16 lb. per cwt.?

9. What is the net weight of 896 cwt. 1 qr. 14 lb., tare 8 lb. per cwt.?

10. What is the net weight of 786 cwt. 3 qr. 21 lb., tare 24 lb. per cwt.?

11. What is the net weight of 336 cwt. 3 qr. 14 lb., tare 21 lb. per cwt.?

12. What is the net weight of 448 cwt. 14 lb., tare 19 lb. per cwt.?

13. What is the net weight of 3 casks, each 22 cwt. 2 qrs. 15 lb., tare 18 lb. per cwt.?

14. What is the net weight of 5 casks, each 73 cwt. 16 lb., tare 25 lb. per cwt.?

15. What is the net weight of 12 barrels of figs, each 2 cwt. 2 qrs., tare 14 lb. per cwt.?

16. What is the net weight of 27 hhds. sugar, each 6 cwt. 14 lb., tare 16 lb. per cwt.?

17. What is the net weight of 134 cwt. 2 qrs. 16 lb., tare 24 lb. per cwt.?

18. What is the net weight of 37 bags of coffee, each 4 cwt. 18 lb., tare 13 lb. per cwt.?

19. What is the net weight of 4 tierces of coffee, each 8 cwt. 3 qrs. 16 lb., allowing tare 2 qrs. 14 lb. per tierce?

20. What is the tret on 24 bags of coffee, each 3 cwt. 16 lb.?

21. What is the tret on 96 cwt. 3 qrs. 14 lb.?

22. What is the net weight of 6786 cwt. 2 qrs., tare 18 lb. per cwt., deducting also tret?

23. What is the net weight of 7 chests of tea, each 16 cwt. 3 qrs. 16 lb., tare 20 lb. per cwt., allowing also tret?

24. What is the net weight of 5 casks of sugar, each 13 cwt. 24 lb., tare 12 lb. per cwt., deducting also tret?

25. How many gallons net are in 14 casks of oil, each weighing 3 cwt. 2 qrs. gross, allowing tare at 15 lb. per cwt., and 7½ lb. per gallon?

26. What is the net weight of 36 bags of cotton wool, each containing 2 cwt. 3 qrs. 5 lb. gross, and allowing draft at 1 lb. per bag, tare at 2½ lb. per 100 lb., and what is the value of it at 1s. 9d. per lb. net?

27. Purchased 7308 lb. of iron, at 3s. 8d. per stone, of 16 lb., and was allowed one stone gratis to the score; what did I pay for it?

28. How much pure gold is there in a mass of 78 lb., allowing 24 dwt. of alloy for each lb. of gold?

NOTE. Allowances in other cases are computed by multiplying the quantity by the rate, and dividing by the number upon which the rate depends.

29. Bought 162 gross of bottles, and was allowed 7 bottles gratis to the gross; how many did I pay for?

30. Delivered 450 bushels of barley to be malted, and during the process it increased in quantity at the rate of 3 bushels on every 7; what quantity of malt had I?

31. A farmer kiln-dried 285 bushels of corn, by which it inlaked 3 bushels on every 40; how much did the dry corn measure?

32. A merchant's capital was £1260, and he has since increased it at the rate of £13 on £20; what is it now?

RATES PER CENT.

The rate at which allowances in money, and other mercantile transactions are made, depends more frequently upon 100, than upon any other number.

When the rate is given, the increase or decrease varies as the number to be increased or diminished, as also does the increased or diminished number.

When the number to be increased or diminished is constant, the increase or decrease varies as the rate; and then the increased or the diminished number varies as the sum or difference of 100 and the rate.

The methods of calculation used in the preceding, as well as in Commission, Insurance, Stocks, Interest, Profit and Loss, and Exchange, may be deduced from these two principles.

COMMISSION AND BROKERAGE.

Commission is the allowance given to an agent for buying or selling goods, negotiating bills, etc.

Brokerage is a charge for procuring sales, transfer of property, etc.

Rule. Multiply by the rate, and divide the product by 100; or take the same parts of the value that the rate is of 100.

Note 1. If the rate contains a fraction, take parts for it; when the rate is below £1 per cent., divide the sum by 100 for the result at £1 per cent., and take aliquot parts for the given rate.

Note 2. The division by 100 may be performed mentally, thus, cut off the units and tens of the £'s, the rest are the £'s of the quotient; double the tens for the shillings, and if the units be 5, or more, add another shilling; then, throwing 5 from the units, annex one-half of the shillings to the remainder for the farthings, deducting one if they exceed 24, or two if they exceed 48.

Ex.—What is the commission on £1764, 16s. 6d., at 3½ per cent.?
Ans. £61, 15s. 4½d. $\frac{3}{25}$.

	£1764, 16s. 6d.		By taking parts of 100 for 3½ per cent.		
	3½				
	5294, 9 6		2½ = $\frac{1}{40}$	£1764, 16s. 6d.	
	882, 8 3		1 = $\frac{1}{100}$	44 2 4¾	$\frac{8}{40}$
100)	£6176, 17s. 9d.			17 12 11½	$\frac{32}{100}$
	£61, 15s. 4½d. $\frac{3}{25}$			£61 15s. 4½d.	$\frac{12}{100}$

Find the Commission or Brokerage upon,

1. £978, at £2⅛ per cent.
2. £436, 13s. at 2¾ 〃
3. £853, at 1$\frac{7}{12}$ 〃
4. £1242, at 2s. 6d. 〃
5. £957, at 3s. 4d. 〃
6. £937, at 7s. 6d. 〃
7. £197,13s.4d. at 1⅝ 〃
8. £673, 17s. at ⅛ 〃
9. £754,14s.4d. at 4s. per cent.
10. £598, at 4s. 6d. 〃
11. £675, at 2s. 9d. 〃
12. £820, at ⅛. 〃
13. £764, at 3½ 〃
14. £829, at 1⅞ 〃
15. £689, 17s. at 12½ 〃
16. £678, 19s. 8d. at 5 〃

17. An agent charges 4¼ per cent. for commission and risk of bad debts; his sales in a year amount to £14780, and his losses to £230: what is his net income?

18. A salesman disposes of woollen goods which amount to £1260, muslins to £1450, and hardware to £850; what is his commission at 2⅛ per cent.?

19. What is the allowance due to a broker for effecting an insurance on £2840, at 3s. 9d. per cent.?

20. Sent my employer an account of the sales of 40 hhds. sugar; the gross amount came to £2200, duty, freight, etc., £754, 14s. 8d., commission on the gross amount, 2¼ per cent.; required the amount of the net proceeds.

21. What is the duty on £784, 14s. 6d., at 12½ per cent.?

22. Purchased goods for my employer to the amount of £654, 14s. 8d., packing, cartage, and porterage, £4, 3s. 8d., commission on the sum laid out, 2¾ per cent.; required the amount of the invoice.

23. An agent is allowed 5½ per cent. for commission and risk of bad debts; what is his income, his sales being £20178, 17s. 6½d., his losses £300, 17s., and his doubtful debts £600, 17s. 6d., valued at 12s. 6d. per pound?

INSURANCE

Is a contract whereby insurance companies, or certain parties called *underwriters*, agree for a percentage or *premium* upon the value insured, to make good any loss which the property insured may sustain from fire or other assigned cause, to the amount stated in the agreement or *policy* of *insurance*.

A duty, which is variable, is charged by Government on all sums insured; the rates of these duties are given in the "Schedule of Stamp Duties."

Questions in insurance are worked as in commission; when the rate is in guineas, add $\frac{1}{20}$ of the sum to itself, then proceed as if the rate were £'s.

Ex. 1.—Find the cost of insuring £4850 at 2½ guineas per cent., and commission 4s. per cent. Ans. £137, 0s. 3d.

Here, £4850+$\frac{1}{20}$ of £4850=£4850+£242, 10s.=£5092, 10s.;

then, £2½ per cent. upon £5092, 10s.	=	£127, 6s. 3d.	prem.
4s. or £⅕ per cent. upon £4850	=	9 14 0	com.
Cost of insuring £4850	=	£137, 0s. 3d.	

1. What should be paid for insuring £3450 on a house at 1s. 6d. per cent.?

2. Find the cost of insuring property to the amount of £375 at 2s. 6d. per cent.

3. An agent insures £3750 at 2 gu. per cent., and charges commission ½ p. c.; find the whole cost.

4. Insured £4735 on a ship at 50s. per cent.; what was the expense of insuring?

5. Find the cost of insuring £65, 13s. 4d. worth of goods on a voyage, at 12s. 6d. per cent.

6. What should be paid for insuring goods to the amount of £275, 16s. 8d. on a voyage at 1½ guinea per cent.?

7. Insured £2650 on a ship at 3½ gu. per cent., commission ⅛ per cent.; she sustained damage to the amount of £575: how much will be recovered, allowing 2 per cent. discount upon the loss?

NOTE.—Deduct the rate and other charges from the damage.

8. Insured £4325 on a cargo at 35s. per cent., com. ½ per cent.; there was lost of it £375: what will be recovered, allowing 1½ per cent. discount upon the loss?

9. What should a person aged 35 years pay annually, to secure £575 for his family at his decease, at £2, 14s. 6d. per cent. per annum?

EX. 2.—What sum must be insured at 35s. per cent., com. ½ p. c., to cover £4692 in case of loss? ANS. £4800.

Here, £100—(£1, 15s.+10s.)=£100—£2, 5s.=£97, 15s., hence £97, 15s. : £100 : : £4692 : £4800 sum to be insured.

Find the sum to be insured to cover in case of loss,

10. £574, 16s. at 4 gu. per cent.
11. £2349, 12s. at 42s. per cent.
12. £197, 8s. at 26s. per cent.
13. £1166, 2s. at 2½ gu. per cent., com. 4s. per cent.
14. £5889, at 37s. per cent.
15. £7690, at 3½ gu. per cent., com. 4s. per cent.

Ex. 3.—What sum must be insured to cover £32041 on a voyage out and home at 10 gu. per cent. Ans. £40000.

Here, £100—£10½ or £89½ : £100 : : £32041 : £40000
By Com. Prop. 89½ : 100

Find the sum to be insured on a voyage out and home,

16. To cover £560 at 5 g. p. c.
17. 〃 £1280 〃 8 g. p. c.
18. 〃 £800 〃 7½ g. p. c.
19. To cover £760 at 4 g. p. c.
20. 〃 £840 〃 3 g. p. c.
21. 〃 £3420 〃 7 g. p. c.

CALCULATION OF AVERAGES.

A general average is a contribution from the owners of the ship and cargo and the underwriters for any loss which may have been sustained on a voyage, for the common safety of the whole.

A particular average is a partial loss occasioned by the common accidents of the sea, and falls upon the owners or insurers of the article lost.

Rule. As the whole value of any article is to the whole loss, so is each man's share of that article to his proportion of the loss; or so is 100 to the average loss per cent.

Note. In computing a general average for masts, cables, and rigging cut away, one-third of the cost of replacing them is deducted for newness; but goods thrown overboard are valued at the sum they would have brought, had they arrived safe.

22. A ship, valued at £3200, sustained damage in her masts, rigging, &c., the expense of replacing which was £877, 10s.; the value of her cargo was £7200, of which £5600 only was insured; freight £1600, of which deduct £300 for expenses: required the average loss per cent., and the share of each party concerned.

23. A ship, on her voyage from Calcutta to London, being overtaken by a storm, sustained the following losses: Masts, cables, and rigging cut away, the expense of replacing which was £600; an anchor lost, which cost £60; 20 pipes of wine, worth £80 per pipe, thrown overboard; of 80 chests of tea, valued at £25 per chest, part was so much damaged, that the deficiency was estimated at 30 chests. The ship was valued at £6000, of which £4000 were insured; of £10000, the value of the cargo, £5000

were insured and the rest risked; the net freight was £1500. Required the average loss per cent., and the share of each party concerned.

24. Insured 60 hhds. sugar, at £40 per hhd., from Jamaica to Leith, at 10 guineas per cent., to return 5 guineas per cent. if the ship sailed with convoy and arrived, which took place; but it turned out that 40 hhds. only were shipped, and they were so much damaged by sea-water that they sold only for £20 per hhd., whereas, had they been sound, they would have brought £25, 10s. 6d. per hhd.; how much must the insurers pay?

NOTE. One-half per cent. is claimed by the insurers upon the value of the 20 hhds. not shipped.

INTEREST

Is the allowance given by the borrower to the lender for the use of his money, and is reckoned at a certain rate on every £100 for a year.

The money borrowed is called the *principal;* and when the interest is added to it, the sum is called the *amount.*

Interest is either Simple or Compound.

SIMPLE INTEREST.

CASE I. To find the interest for any number of years.

RULE. Multiply the principal by the number of years and by the rate per cent., then divide by 100.

NOTE. For months take parts of a year.

Ex.—Find the interest of £525, 17s. 6d. for 4 years at 2½ per cent. ANS. £52, 11s. 9d.

Here, £525, 17s. 6d. × 4 × 2½ ÷ 100 = £5258, 15s. ÷ 100 = £52, 11s. 9d. interest.

CASE II. To find the interest for any number of days.

RULE. Multiply by the number of days, and by twice the rate, then divide by 73000, *i.e.* (365 × 2 × 100).

Ex.—Find the interest of £428, 2s. 6d. for 219 days at 4 per cent. ANS. £10, 5s. 6d.

Here, £428, 2s. 6d. × 219 × 8 ÷ 73000 = £750075 ÷ 73000 = £10, 5s. 6d. interest.

Required the interest of,

1. £754, 14s. 8¾d. for a year, at 4 per cent.
2. £1256, 14s. 8½d. for 7 years, at 3½ per cent.
3. £928, 18s. for 8¾ years, at 4⅝ per cent.
4. £2346, for 9 years, 7 months, at $4\frac{7}{12}$ per cent.
5. £127, 15s. 7½d. for 19 months, at 4 guineas per cent.
6. £98, 19s. 6d. for 11 months, at 3¾ per cent.
7. £364, 17s. 5d. for 5 months, at 3¼ per cent.
8. £36, 17s. 7d. for 9 months, at 4⅓ per cent.
9. £560 for 7 weeks, at 4 per cent.
10. £1240 for 19 weeks, at 3 per cent.
11. £3204, 14s. for 37 days, at 5 per cent.
12. £780, 14s. 9½d. for 36 days, at 4 per cent.
13. £874, 18s. 8¾d. for 29 days, at 4¼ per cent.
14. £910, 15s. for 68 days, at 4⅛ per cent.
15. £653, 6s. 8d. for 58 days, at 4¾ per cent.
16. £780 for 257 days, at 3¾ per cent.
17. £584 for 308 days, at 3⅜ per cent.
18. £256 from May 7 to August 12, at 4⅛ per cent.
19. £154 from Jan. 7 to July 23, at 4⅝ per cent.
20. £630 from Sept. 16 to Jan. 23, at 4¼ per cent.
21. £740 from March 8 to July 12, at $3\frac{7}{12}$ per cent.
22. Lodged in the bank £230 on May 24; what interest will be due upon it, on Nov. 16, at $3\frac{5}{12}$ per cent.?

Find the amount of,

23. £789 for 36 days, at 5 per cent.
24. £910, 15s. for 27 days at 5 per cent.
25. £874 for 68 days, at 5 per cent.
26. £608, 6s. 8d. for 58 days, at 4 per cent.
27. £780 for 257 days, at 3 per cent.
28. £850 for 308 days, at 4½ per cent.
29. £260 from May 7 to Sept. 12, at 4 per cent.
30. £150 from Jan. 7 to Aug. 23, at 4¾ per cent.
31. £630 from Sept. 12 to Jan. 27, at 4¼ per cent.
32. £720 from March 8 to June 7, at 3 per cent.
33. May 27, lodged in the bank £230, one half at 3 per cent. and the other half at 4 per cent.; how much may be drawn, including the interest, on September 18?

To DIVIDE BY 73000, *i.e.*, to *multiply* by 1 ÷ 73000, or ·0000137.

Ex.—Required the interest of £956, 14s. 6d. for 7 days, at 4½ per cent. ANS. 16s. 6d.

Having multiplied by the days, and by twice the rate, multiply by 3, writing the product a place farther to the right; next subtract, and write the remainder a place farther to the right; then add the 3 lines, and point off *seven* more decimals in the sum than were in the multiplicand. This approximation may be carried to any degree of exactness by writing the same figures 4 places farther to the right, and *subtracting;* then writing them again four places to the right, and *adding;* and so on, *subtracting* and *adding* alternately.

$$\begin{array}{r}
£956{\cdot}725 \times 7 \\
\hline
6697{\cdot}075 \times 9 \\
\hline
60273{\cdot}675 \\
18082\ 1025 \\
4219\ 15725 \\
\hline
£{\cdot}82574\ 93475 \\
8\ 25749 \\
\hline\hline
\end{array}$$

34. Find the interest of £854 for 42 days, at 3¾ per cent.
35. Find the int. of £1248, 16s. for 11 weeks, at 3½ p. c.
36. Find the interest of £750 for 19 weeks, at 4¼ per cent.
37. Find the interest of £896 for 3⅜ years, at 4⅝ per cent.

CASE III. To find the interest, when partial payments are made at short intervals of time.

RULE. Multiply the principal and the successive balances by the number of days between the times of payment; then multiply the sum of these products by double the rate per cent., and divide by 73000.

Ex.—A bill of £500 became due March 12, of which £150 were paid April 7; £200 June 28; and the balance Sept. 15: required the interest at 5 per cent.

From Mar. 12 to April 7 is 26 days, from April 7 to June 28 is 82 days, and from June 28 to Sept. 15 is 79 days; the *sum due* and the *balances* are multiplied by the days.

Dates.		Sums.	Days.		Prod.
Mar. 12.	Due	£500	× 26	=	13000
April 7.	Paid	150			
	Bal.	350	× 82	=	28700
June 28.	Paid	200			
	Bal.	150	× 79	=	11850
Sept. 15.	Paid	150			
				7300)	53550
		Interest,			£7, 6s. 8½d. + [illegible]

38. Required the interest on a bill of £456, due May 7, of which £120 were paid June 18; £116 Sept. 27; £136 Nov. 17; and the balance Dec. 27, at 4½ per cent.

39. Required the interest on a bill of £1000, due March 13, of which £300 were paid April 7; £234 May 13; £230 July 28; and the balance Oct. 18, at 4¾ per cent.

40. Required the interest on a bill of £900, due Jan. 1, of which £150 were paid Feb. 28; £270 March 30; £173 June 19; £213 July 28; £57 Sept. 23; and the balance Nov. 17, at 3¾ per cent.

41. Borrowed March 20, £1000, of which I paid £300 Sept. 17; £150 Dec. 21; £220 Feb. 23; and the balance July 23: how much was then due, principal and interest, at 4 per cent.?

42. Lent Jan. 20, £2000, of which I received April 7, £350; Sept. 28, £690; Dec. 18, £420; and the balance April 7: how much was then due, principal and interest, at 4½ per cent.?

CASE IV. To find the interest on Accounts-current.

An Account-current contains a statement of the money transactions between two persons, arranged in the form of *Dr*. and *Cr*. The Dr. or left hand side contains the sums paid *by* the party furnishing the account; the Cr. or right hand side, those paid *to* him.

Rule. Add and subtract the sums paid and received in the order of their dates. Find the number of days between the different transactions, and multiply them by their respective balances; if the balances are sometimes due to the one party and sometimes to the other, extend the products in different columns, then add them, and when the rates of interest are different, multiply each sum by twice its rate, and divide the difference of the products by 73000.

Ex.—Find the interest on the following account, at 4½ per cent. ANS. £2, 1s. 3¼d. $\frac{103}{365}$

Dr. M. N.'s account-current with W. H. *Cr.*

Jan.	1.	To cash,	.	£120	Jan.	17.	By cash,	.	£200
Mar.	18.	To cash,	.	180	July	7.	By cash,	.	60
Aug.	24.	To cash,	.	320	Sept.	14.	By cash,	.	400
Oct.	8.	To cash,	.	250					

Dates.	Dr. or Cr.	Sums.	Days.	Dr. Products.	Cr. Products.
Jan. 1.	Dr.	£120	16	1920	
Jan. 17.	Cr.	200			
	Cr.	80	60		4800
Mar. 18.	Dr.	180			
	Dr.	100	111	11100	
July 7.	Cr.	60			
	Dr.	40	48	1920	
Aug. 24.	Dr.	320			
	Dr.	360	21	7560	
Sept. 14.	Cr.	400			
	Cr.	40	24		960
Oct. 8.	Dr.	250			
	Dr.	210			
	Sum of Dr. products,			22500	5760
	" " Cr. "			5760	
	Diff. of products, .			16740	
	Mult. by 4½ × 2, .			9	
			73000)	150660	
			Interest,	£2, 1s. 3¼ $\frac{100}{365}$d.	

43. Find the interest on the following account, at 5 p. c.

Dr. Mr Simson's account-current with W. F. & Co. *Cr.*

Jan. 7.	To balance,	£210	April 14.	By cash, .	£130
Mar. 7.	To cash, .	150	June 27.	By cash, .	215
May 8.	To cash, .	240	Aug. 13.	By cash, .	167
July 21.	To cash, .	300	Oct. 12.	By cash, .	280
Sept. 18.	To cash, .	250	Nov. 18.	By cash, .	120
Dec. 24.	To cash, .	160			

44. On the following account at 4 per cent.

Dr. S. M. & Co.'s account-current with N. M. *Cr.*

May 1.	To balance,	£250	June 8.	By cash, .	£124
June 28.	To cash, .	140	July 19.	By cash, .	230
Aug. 11.	To cash, .	340	Oct. 20.	By cash, .	150
Nov. 12.	To cash, .	221	Dec. 12.	By cash, .	200

45. On the following account to November 30; allowing 5 per cent. to A. B., and 4 per cent. to R. S.

Dr. A. B.'s account-current with R. S. *Cr.*

Dec.	7.	To balance,	£103	Mar.	13.	By cash,	£354
Feb.	13.	To cash,	118	June	3.	By cash,	275
April	28.	To cash,	400	Aug.	17.	By cash,	100
Sept.	5.	To cash,	350	Nov.	18.	By cash,	255

46. On the following account, to February 21, allowing T. M. & Co. 4¼ per cent. and G. H. 3¾ per cent.

Dr. G. H.'s account-current with T. M. & Co. *Cr.*

June	8.	To balance,	£107	Aug.	7.	By cash,	£400
July	25.	To cash,	230	Oct.	3.	By cash,	220
Sept.	7.	To cash,	321	Dec.	27.	By cash,	180
Nov.	21.	To cash,	161				
Dec.	23.	To cash,	140				

47. On the following account, to April 30, allowing F. R. 5 per cent., and R. C. 3¾ per cent.

Dr. F. R.'s account-current with R. C. *Cr.*

Mar.	8.	To balance,	£80	June	18.	By cash,	£172
July	4.	To cash,	74	Sept.	23.	By cash,	98
Oct.	29.	To cash,	108	Nov.	15.	By cash,	148
Dec.	17.	To cash,	217	Feb.	28.	By cash,	150
Jan.	18.	To cash,	135				

The following examples are solved by Simple and Compound Proportion.

48. In what time will the interest of £325, 7s. 6d. pay a debt of £43, 7s. 8d. at 4 per cent.?

49. How long should £466, 13s. 4d. be lent at 2½ per cent., to amount to £530, 16s. 8d.?

50. At what rate per cent. should £522, 17s. 6d. be lent for 3⅓ years to amount to £566, 8s. 11½d.?

51. In what time will any sum double itself at 2, 2½, 3, 5, and 6⅔ per cent.?

52. At what rates per cent. will any sum treble itself in 20, 25, 33⅓, 50, and 75 years?

53. Borrowed £533, 6s. 8d. for 219 days, and paid £542, 18s. 8d.; what rate per cent. per annum was charged for the loan?

54. What sum put out to interest for 5 years at 2½ per cent. will amount to £477, 18s. 9d.?

DISCOUNT

Is the method of finding the *principal* and *interest*, when the *amount*, *rate*, and *time* are given.

Rule. As the amount of £100 for the time and rate is to £100, so is the debt to the present value or principal.

Note.—To find the discount, subtract the present value from the debt.

Ex. 1.—Find the present value of £275, 17s. 9d., due 2 years hence, at 2½ per cent. Ans. £262, 15s.

Here, the interest of £100 for 2 years, at 2½ per cent., is £5. Hence, £105 : £100 : : £275, 17s. 9d. : £262, 15s. present value, and £275, 17s. 9d. — £262, 15s. = £13, 2s. 9d. the discount for present payment.

Find the present worth of,

1. £350, due 146 days hence at 5 per cent.
2. £225, due 2 months hence at 5 per cent.
3. £212, 10s., due 73 days hence at 5 per cent.
4. £352, 12s. 10d., due 3 years hence at 3⅓ per cent.
5. £496, 5s. 6d., due 3½ years hence at 2½ per cent.

Find the discount on,

6. £410, due 55 days hence at 5 per cent.
7. £150, due 4 months hence at 5 per cent.
8. £334, 7s. 9d., due 125 days hence at 4 per cent.
9. £1926, 12s. 4½d., due 79 days hence at 2¼ per cent.
10. £1000, 7s., due 4 years hence at 3½ per cent.
11. Bought goods for £65, and 4 months' credit, and am offered a discount of £5 for present payment; at what rate per cent. is the offer made?
12. The present value of £393, 1s. 10d., due a certain time hence, is £365, 13s. 4d.; required the time, interest at 3 per cent.

In discounting bills, bankers retain the interest upon them during the time they have to run, with, in this country, 3 *days* of *grace*, and sometimes also ½ per cent. commission; the remainder is called the net proceeds.

Note.—When the term is given in months, kalendar months are understood; thus, a bill dated Nov. 28, 29, or 30, at 3 months, is due on March 3.

Ex. 2.—Find the net proceeds of a bill of £191, 12s. 6d., dated March 8, at 3 months, and discounted April 12, at 5 per cent. Ans. £190, 1s.

Here, three months from March 8 is June 8, then from April 12 to June 11 is 60 days. Hence, £191, 12s. 6d. × 60 × 10 ÷ 73000 = £1149, 15s. ÷ 730 = £1, 11s. 6d. the discount, and £191, 12s. 6d. — £1, 11s. 6d. = £190, 1s. net proceeds.

13. Find the discount upon a bill of £573, 16s. 8d., dated 4th March, at 4 months, and discounted May 3 at 5 per cent.

14. Find the net proceeds of a bill of £478, 14s., dated July 6, at 2 months, and discounted July 24 at 4½ p. cent.

15. What is the discount on a bill of £237, 12s., dated Oct. 16, at 5 months, and discounted Jan. 12 at 3¾ p. cent.?

16. What is the net proceeds of a bill of £348, dated Jan. 25, at 6 months, which was discounted May 3 at 5 per cent., and commission ½ per cent.?

17. Required the discount of a bill for £579, dated 24th May, at 3 months, discounted 6th June at 5 per cent.

18. Required the net proceeds of the following bills, discounted on the 17th Sept.: W. S. on I. M., £450, dated 12th Aug., at 4 months; S. T. on A. B., £346, 10s., dated 29th July, at 5 months; D. E.'s bill of £196, dated 3d Sept., 3 months, and E. G. on H. L., £268, dated 1st Aug., 3 months, deducting 5 per cent. and ¼ p. c. commission.

STOCKS.

Stock is the term applied to the capital of any banking, mercantile, insurance, or railway company; and to the money borrowed by Government for national purposes, which constitutes the National Debt.

The various kinds of stock are distinguished by the particular rate per cent. which they yield per annum; thus, stock, which yields 5 per cent. per annum, is termed *five* per cent. stock, or simply the *five* per cents.

Stock is generally bought and sold at so much sterling for every £100 of stock.

When £100 *stock* is worth £100 sterling, the stock is said to be at *par*. The price, however, is continually fluctuating; thus, when the *three* per cents. are quoted at 88½, it signifies that £100 of this stock is worth £88½ sterling, and that £3 is the annual interest or dividend upon £100 stock or its sterling value £88½. In the transference of stocks, brokers are employed, and usually charge ⅛ per cent. upon the stock transferred.

The following examples illustrate the various methods of solving questions in stocks:—

Ex. 1.—How much sterling money should be paid for £4250 three per cents., at £88½ per cent.?

Here, £100 : £4250 : : £88½ : £3761, 5s. sterling.

Ex. 2.—How much three per cents., at £88⅜ per cent., may be purchased for £3761, 5s., including brokerage ⅛ per cent.?

Here, £100 *stock* costs £88½ sterling; hence, £88½ : £3761, 5s. : : £100 : £4250 stock.

Ex. 3.—What annual income is derived by investing £3761, 5s. in the three per cents., at 88½?

Here, £88·5 : £3761·25 : : £3 : £127, 10s. annual income.

Ex. 4.—At what rate should money be invested in the three per cents. to produce 3½ per cent. interest?

Here, £3½ : £3 : : £100 : £85⁵⁄₇ per cent.

1. How much India *five* per cents., at 104¼, may be purchased for £1640, 4s.?
2. What should be paid for £3420 bank stock (10 per cent.) at 243?
3. How much stock at 152½ can be purchased for £1822, 7s. 6d.?
4. What is the value of £1260 stock at 65⅜ per cent.?
5. What annual income is derived by investing £1058, 18s. 4d. in bank stock at 242⅜, including brokerage ⅛ per cent.?
6. When the *three* per cents. are at 88⅜, bank stock at 244, and India *five* per cents. at 104¼; which is the preferable investment?
7. What income will a person derive annually by in-

vesting £926, 2s. in Great Northern Railway stock (8¾ per cent.) at £135 per cent.?

8. What should be paid for £476, 7s. 6d. South-Eastern Railway stock at 92⅜, including brokerage ⅛ per cent.?

9. At what rate should money be invested in India *five* per cents. to yield 4 per cent.?

10. What is the price of bank stock, when £6396, 19s. 6d. invested in it produces £263, 5s. yearly?

11. Invested £2297, 15s. in *three* per cents. at 88⅜, and sold out at 88⅞; what was the gain?

12. If £3365, 11s. be invested in the *five* per cents. at 103¾, and sold out at 104¼; what difference will it make in my income to reinvest the proceeds in bank stock at 242⅞ per cent., brokerage ⅛ per cent.?

13. Purchased an estate, which let for £530, 9s. yearly, at 21 years' purchase; how much *five* per cents. at 103 must be sold out to pay for it?

14. If £2153, 6s. be invested in the *three* per cents. at 88½; at what rate should it be sold to gain £9, 3s.?

15. A gentleman has £3753, 6s. 8d. in the *three* per cents. at 88⅛; how much should he invest in the *five* per cents. at 104 to secure £274, 12s. yearly, brokerage ⅛ per cent.?

16. How much bank stock at 244 must be sold out to pay a debt of £500, brokerage ⅛ per cent.?

17. A person has ¼ of his money in the *three* per cents., ⅓ in the *five* per cents., ⅙ in bank stock, and £2300 in stock which yields 8 per cent.; what is his annual income?

18. What rate per cent. is derived by purchasing into the *four* per cents. at 104⅞, brokerage ⅛ per cent.?

19. Invested £3040, 4s. in 4½ per cents. at 108; at what price should it be sold out, so as to gain £35, 3s. 9d.?

20. If £4134, 7s. 6d. be invested in the *three* per cents. at 87½, and sold out at 88⅝; what difference will it make in my yearly income, to reinvest the proceeds in the *four* per cents. at 102½?

EQUATION OF PAYMENTS

Is the method of finding the time when several debts, due at different times, may be equitably paid at once.

Rule. Multiply each debt by the time which must elapse before it is due; the sum of the products, divided by the sum of the debts, will give the equated time nearly.

Ex.—Find the time for paying at once, £20 due in 3 months, £30 due in 4 mo., £40 due in 6 mo., and £50 due in 7 months. Ans. 5½ months.

Here, (£20 × 3) + (£30 × 4) + (£40 × 6) + (£50 × 7) ÷ (20 + 30 + 40 + 50) = (60 + 120 + 240 + 350) ÷ 140 = 770 ÷ 140 = 5½ months.

1. I owe £60 in 40 days, £80 in 60 days, and £120 in 108 days; when ought the whole to be paid?

2. I owe £74 in 50 days, £108 in 250 days, and £100 in a year; required the equated time for paying the whole.

3. I owe £100 in 30 days, £270 in 118 days, and £365 in one year and 110 days; when ought the whole to be paid?

4. £240 is to be paid as follows: £60 in 60 days, £80 in 96 days, £40 in 250 days, and the rest in a year and 35 days; required the equated time for paying the whole.

5. Find the equated time for paying at once ⅓ of a debt due on Christmas, ⅕ on Lady-day, ¼ on Midsummer-day, and the rest on Michaelmas.

The following exercises may be solved in the same way.

Find the average price per gallon, etc., of,

6. 7 galls. whisky at 14s. 6d. per gal., 8 at 15s., 10 at 15s. 6d., 12 at 16s., 15 at 16s. 6d., 17 at 17s. 6d., and 18 galls. at 18s. per gallon.

7. 8 lb. of tea at 3s. per lb., 10 at 3s. 4d., 12 at 3s. 6d., 12 at 3s. 9d., 15 at 4s., 18 at 4s. 3d., and 20 at 4s. 6d.

8. 20 qrs. of wheat at 40s. per qr., 25 at 40s. 3d., 30 at 40s. 6d., 35 at 41s. 6d., 40 at 42s. 3d., 45 at 43s. 6d., and 50 at 44s. per qr.

9. A corn merchant mixes 8 qrs. of oats at 20s. 9d. per qr., 12 at 21s., 16 at 21s. 6d., 20 at 22s., 24 at 22s. 6d., and 28 at 23s.; how should he sell it per quarter to gain £6, 15s. 6d. on the whole?

10. A grocer mixes 7 lb. of tea at 3s. 2d. per lb. with 14 at 3s. 4d., 21 at 3s. 6d., 28 at 3s. 8d., and 35 at 4s.; at what rate should he sell it per lb. to gain £1, 6s. 3d. on the whole?

11. A goldsmith melts 4 oz. of gold 22 carats fine, with

6 oz. 21 carats fine, 8 oz. 18 carats fine, 10 oz. 15 carats fine, 12 oz. 12 carats fine, and 14 oz. 9 carats fine; what was the average fineness of the mixture per oz.?

12. The pressure of the atmosphere as indicated by a barometer was 30·000 in. on 5th August, on the 6th, 29·953, on the 8th, 29·841, on the 9th, 29·622, on the 10th, 30·169, and on the 11th, 30·331; what was the average pressure during these 6 days?

PROFIT AND LOSS

Treats of the gains and losses of merchants, and enables them to fix the prices of their goods so as to gain or lose so much on the whole or any part of them, or so much per cent. upon them.

The price at which the goods are purchased is called the *prime cost*, that at which they are sold, the *selling price*. When the selling price is the *greater* of the two, their difference is termed *profit;* when the *less*, it is termed *loss*.

Questions under this head are solved by Simple and Compound Proportion, Practice, etc.

Ex. 1.—Bought tea at £18, 13s. 4d. per cwt., and sold it at 3s. 8d. per lb.; what was the gain per cwt.?

Here, 112 lb. at 3s. 8d. = £20, 10s. 8d. S. P. per cwt.
18 13 4 B. P. "
Difference, £1, 17s. 4d. gain. "

Ex. 2.—Bought sugar at 5d. per lb.; how many lbs. must be sold at $6\frac{1}{4}$d. per lb., to gain £1, 18s. 9d.?

Here, ($6\frac{1}{4}$d. — 5d.) : £1, 18s. 9d. :: 1 lb. : 372 lb.

1. Bought 428 yards of cloth, at 14s. 8d., and sold it at 16s. 3d.; what did I gain?

2. Bought 57 cwt. of sugar, at £4, 3s. 6d. per cwt., and sold it at $9\frac{3}{4}$d. per lb.; what was gained?

3. Bought 136 yards of muslin, at 3s. 8d.; how must a yard be sold to gain £12 on the whole?

4. Sold 257 yards of linen, at 3s. 9d., and lost £9; what was a yard bought at?

5. Sold 13 dozen pairs of stockings at 3s. 7d. per pair, and gained £11, 10s.; what were they bought at?

6. Bought cloth at 17s. 6d.; how much of it must be sold at 19s. to gain £43, 13s. 6d.?

7. By selling tobacco, which had been bought for £14, 10s. per cwt., at 3s. 6d. per lb., I gained £130; how much did I sell?

8. By selling sugar, which had been bought for 4 guineas per cwt., at 8¼d. per lb., I lost £85; what quantity did I sell?

9. Bought 236 feet of wood, at 3s. 10d., and sold it at 3s. 5d. per foot; what did I lose on it?

10. Bought 234 cwt. of iron at 4s. 8d. per stone, of 14 lb., but I am willing to lose £14, 12s. in selling it; what should it be sold at per lb.?

Ex. 3.—Bought oats at 21s. 3d. per qr., and sold it at 22s. 3¾d. per qr.; what was the gain per cent.?

Here, 22s. 3¾d. — 21s. 3d. = 1s. 0¾d. gain on 21s. 3d.; hence, 21s. 3d. : 1s. 0¾d. : : £100 : 5 per cent.; *i.e.*, the prime cost is to the profit or loss upon it, as £100 is to the profit or loss per cent.

11. Bought cloth at 3s. 8d., and sold it at 4d. per yard profit; what was the gain per cent.?

12. Sold cloth worth 15s. per yard, at a loss of 1s. 6d. per yard; what was the loss per cent.?

13. Bought cloth at 9s. 6d. per yard, and sold it at 12s.; what was the gain per cent.?

14. Bought tea at 5s. 6d. per lb., but getting damaged, I was obliged to sell it at 4s. 9d.; what was the loss per cent.?

15. Bought 7 cwt. 3 qrs. of sugar at 5¾d. per lb., and sold it at 9d.; what did I gain per cent., and in all?

16. How much profit per cent. is 2½d. per shilling?

17. Bought a house for £315, paid for repairs £20, and sold it for £400; what was the gain per cent.?

Ex. 4.—Bought tea at 3s. 4d. per lb.; at what price should it be sold per lb., to gain 10 per cent.?

Here, £100 : £110 : : 3s. 4d. : 3s. 8d. S. P. per lb.; *i.e.*, £100 is to (£100 *plus* the rate p. c. in case of *gain*, or *minus* it in case of *loss*), as the prime cost is to the selling price.

18. Gained $9\frac{1}{11}$ per cent. by selling cloth, which I bought at 3s. 8d.; what did I sell it at?

19. Lost 10 per cent. by selling cloth which I bought at 15s.; what did I sell it at?

20. Bought cloth at 9s. 6d.; at what must I sell it to gain 26$\frac{6}{19}$ per cent.?

21. Bought tea at 5s. 6d. per lb., but getting damaged, I am obliged to lose 13$\frac{7}{11}$ per cent. by it; at what must I sell it per lb. to lose so much?

22. Bought sugar at 5$\frac{3}{4}$d. per lb.; what must I sell it at per lb. to gain 56$\frac{12}{23}$ per cent.?

23. Bought tea at 4s. per lb.; at what must I sell it per lb. to gain 20$\frac{5}{6}$ per cent.?

Ex. 5.—Gained 10 per cent. by selling tea at 3s. 8d. per lb.; what was the prime cost per lb.?

Here, £110 : £100 : : 3s. 8d. : 3s. 4d. P. C. per lb.; *i.e.*, (£100, *plus* the rate per cent. in case of *gain*, or *minus* it in case of *loss*,) is to £100, as the selling price is to the prime cost.

24. If I gain 9$\frac{1}{11}$ per cent. on cloth which I sold at 4s.; what was the prime cost?

25. Lost 10 per cent. on cloth, which I sold at 13s. 6d.; what was the prime cost?

26. Lost 13$\frac{7}{11}$ per cent., by selling tea at 4s. 9d.; what was the prime cost?

27. Gained 56$\frac{12}{23}$ per cent. by selling goods at 9d.; what was the prime cost?

28. Sold a quantity of cloth at 4s. 10d. per yard, by which I cleared 20$\frac{5}{6}$ per cent.; what did I buy it for?

29. Sold cloth at 12s., on which I gained 26$\frac{6}{19}$ per cent.; what was the prime cost?

Ex. 6.—By selling brandy at 36s. per gal., 5 per cent. is gained; what is gained or lost per cent. by selling it at 42s. per gallon?

Here, 36s. : 42s. : : £105 : £122$\frac{1}{2}$, and £122$\frac{1}{2}$ — £100 = 22$\frac{1}{2}$ per cent. gain; *i.e.*, the price whose rate per cent. is given is to the other price, as (£100 *plus* or *minus* the rate) is to a result, from which subtract £100 for the gain per cent., or which subtract from £100 for the loss per cent.

30. By selling cloth at 5s., I gained 12 per cent.; what did I gain per cent. by selling it at 6s.?

31. By selling goods at 8s., I lost 14 per cent.; what did I lose by selling them at 7s. 6d.?

32. Sold goods at 15s. 6d., whereby I cleared 18 per cent., but the commodity turning scarce, I sold what remained at 16s. 4d.; what did I clear per cent. by the latter price?

33. By selling tea at 5s. 3d., I gained 16 per cent.; the same tea was afterwards sold at 4s. 6d.: what was lost or gained per cent. by the latter price?

Ex. 7.—If £15, 8s. 9d. be gained by selling goods at a profit of 7½ per cent.; what was paid for them?

Here, £7½ : £100 : : £15, 8s. 9d. : £205, 16s. 8d. P. C.; *i. e.*, the rate is to £100, as the gain or loss is to the buying price.

34. By selling goods at 5 per cent. profit, I gained £44, 16s.; what did I pay for them?

35. I lost £34, 18s., on a quantity of cloth at 4 per cent.; what was it bought and sold for?

36. Sold 342 cwt. sugar at 3 per cent. profit, and gained £53, 14s.; what was it bought and sold at per cwt.?

37. Bought muslin at 5s. 8d., and by selling it at 4¼ per cent. profit, I gained £29, 18s.; what quantity did I sell?

38. Sold cloth for 7s. 8d., which was at 6 per cent. profit, and gained £33, 6s. 8d.; what quantity did I sell?

39. By selling 386 gall. rum at 3 per cent. loss, I lost £19, 18s. 6d.; what was it bought and sold at per gallon?

PROMISCUOUS EXERCISES.

1. Bought cambric at 4s. 3d. per yard, and sold it at 5s. 8d. per English ell; what was gained or lost on four pieces, each 15 yards, and how much per cent.?

2. Bought goods at 6s. 3d. per quarter, and sold them at £1, 18s. 6d. per cwt.; what was gained on 27 cwt., and how much per cent.?

3. Bought cloth at 15s. per yard; how must it be sold per yard to gain £3, 6s. 8d. on 80 yards, and what will be the gain per cent.?

4. Bought a cask of rum, containing 252 gallons, at 8s. 6d. per gallon; but having lost 24 gallons by leakage, I wish to know at what I must sell the remainder per gallon, so as to make up the prime cost of the whole.

5. Bought 17 cwt. 3 qrs. of sugar for £49, 14s., and retailed it at 9½d. per lb.; what was gained on the whole, and how much per cent.?

6. A merchant sold 4 cwt. 3 qrs. of tea for £136, 8s., gaining 10 per cent.; what was the prime cost per lb.?

7. Bought hops at 5 guineas per cwt.; how must they be sold per lb. to gain 15 per cent.?

8. By selling cloth at 17s. 6d. per yard, I cleared 8 per cent.; how much did I clear per cent. by selling the same cloth at 18s. 3d.?

9. Bought 69 gallons brandy and 57 gallons rum, all at 8s. 6d.; the brandy is sold at 10s. 2d.; at what must the rum be sold to gain 20 per cent. on the whole?

10. If I gain 10 per cent. by selling at 2d. per lb., what do I gain or lose per cent. by selling at 1¾d. per lb.?

11. Sold 33 pipes of wine for £410, 0s. 6d., gaining as much as I sold 3 pipes for; what was my gain per cent.?

12. A merchant imported 11 pipes of wine, which cost him thirty guineas per pipe, and which were bottled into 52 dozen each; bottles and other charges 2s. 4d. per dozen; he sold one-half of it at 16s. 2d. per dozen, and the other half at 17s. per dozen: what did he gain or lose upon the whole?

13. A maltster purchases 400 chaldrons of barley at £5, 10s. per chaldron; he pays malt-house rent £25, servants' wages £60, and duty 10¼d. per bushel; the malt is sold at 3s. 10d. per bushel, and supposing he had 40 bushels of malt for each chaldron of barley, what was the gain or loss on the whole, and how much per cent.?

14. Shipped on an adventure to Lisbon 300 barrels of salmon at £3, 18s. 6d., 450 yards of linen at 2s. 7d., 1200 yards broad cloth at 16s., insurance and charges of shipping £44, 8s. 6d.; the net proceeds was £2440, 16s. 4d.: required the gain or loss, and how much per cent.

15. Shipped for Bordeaux 1200 qrs. of wheat at 39s. 6d., 600 qrs. of barley at 25s. 6d., 400 yards of cloth at 15s., insurance on £1800 at 3 guineas per cent., duty 4s. p. c., commission and other charges £18, 10s.; the net proceeds was £3618, 14s. 6d.; required the gain or loss.

16. Sold a quantity of cloth at 3s. 3d. per yard, by which I gained £12, at the rate of 8⅓ per cent.; required the quantity sold, and the prime cost.

17. Bought quills at 15s., which I sold at £1, 4d., and four months' credit; required the gain p. c., int. at 5 p. c.

18. Bought paper at 12s.; at what must I sell it, and give 6 months' credit, to gain 10 p. c., int. at 5 p. c.?

19. What shall I gain or lose per cent. by selling tea, for which I paid £25 per cwt. a year ago, at 5s. 4d. per lb. and 8 months' credit, int. at 5 p. c.?

20. Sold cheese at 10¾d. per lb., and gained 7⅛ per cent.; what was it bought at per cwt.?

21. Bought sugar at £4·286 per cwt.; how must it be sold per lb. to gain 6⁴⁄₁₅ per cent.?

22. Purchased 94⅜ yards of cloth, at £·784 per yard; how must it be sold per yard to gain £11⅚ on the whole?

23. Sold muslin at 4s. 9d. and gained 3¾ per cent.; what was it bought at?

24. Sold sugar at 9⅛d., and thereby lost ⅞ per cent.; but it rose to 10¹¹⁄₁₈d.: what was then gained or lost per cent.?

25. By selling stockings at 3¾s. per pair, I gained 1⁵⁄₇ per cent.; how must they be sold to gain 8½ per cent.?

26. Bought 3 cwt. 1 qr. 17 lb. of sugar for £13·3864̇3, and sold it at ¹⁷⁄₁₈s. per lb.; what did I gain in all, and p. c.?

27. After keeping 350 quarters of barley, purchased at 32s., in my possession 4 months, during which time it inlaked 3 per cent. in measure, I exchanged it for 6 dozen bottled beer per quarter, which I sold at 5s. 6d. per dozen; what did I gain or lose, reckoning interest at 5 per cent.?

28. By selling an article for £52, 5s., I lost 5 per cent., and recovered the loss by selling another for £37, 15s.; what was the profit per cent. on the last article?

29. Bought a horse for £100, and sold it for £122 and 4 months' credit, interest at 5 per cent.; required the gain per cent.

30. A bought wine to the amount of £2250, and sold it to B for £2475, who disposed of it to C at a profit of 5 per cent.; how much p. c. above the prime cost did C pay?

31. By selling apples at 5 for 2d., 3 per cent. is gained; what is gained or lost per cent. by selling at 3 for 1d.?

DISTRIBUTIVE PROPORTION

Is the method of dividing a number into parts proportional to as many given numbers.

The shares of the gains or losses of merchants in company are obtained by this rule, and it is then called Simple or Compound Partnership or Fellowship; *Simple* when the share of each depends upon his stock *alone*, *Compound* when it depends upon his *stock* and the *time* of its continuance.

SIMPLE FELLOWSHIP.

Rule. As the sum of the proportionals or stocks is to each individually, so is the number to be divided to the required parts or shares.

Ex.—Two merchants in company gain £175, 6s. 8d.; A's stock is £400, and B's £600; what share of the gain should each receive?

Here, £400 + £600 = £1000, sum of proportionals.
Hence, £1000 : £400 :: £175, 6s. 8d. : £70, 2s. 8d. A's share.
£1000 : 600 :: 175 6 8 : 105 4 0 B's „
Shares of A and B together, £175, 6s. 8d. Proof.

1. Divide 120 into 3 parts, which shall be as 3, 4, and 5.
2. Divide 960 into parts proportional to 1, 3, and 5.
3. Three men, A, B, and C, make a joint stock; A's stock is £64, B's £88, and C's £96; they continue in trade until their profits are £108; required their shares.
4. Four merchants freight a ship to Barbadoes; the value of the cargo is £1260, whereof A's share is £540, B's £360, C's £240, and D's the rest; they gain £220: required each man's share of it.
5. M, N, and P make a joint adventure to Jamaica; M's advance is £230, N's £324, and P's £336; they lose £144; required the loss of each.
6. B's stock is £940, C's £560, and D's £840; they lose £240; required their shares of the loss.
7. A, B, and C continue in trade for a year, with a stock of £1200; at the end of which A's gain was £40, B's £64, and C's £56; required their stocks.

8. A common, consisting of 240 acres, is to be divided among L, M, and N, in proportion to their estates; L's estate is £400 a-year, M's £350, and N's £200; what is each man's share?

9. A bankrupt's assets are £4377, 17s. 6d.; he owes to L £750, 12s., to M £800, 16s., to N £840, 8s. to O £900, to P £960, 18s., and to Q £1000, 15s.; what can he pay per £1, and how much will each receive?

10. Four regiments of infantry, each respectively 840, 900, 960, and 1000 men strong, require to furnish 555 men for a particular service; how many men should each regiment furnish?

11. Divide £840, 7s. 6d. into five shares, so that ½ of the 1st, ⅓ of the 2d, ¼ of the 3d, ⅕ of the 4th, and ⅙ of the 5th may make the same sum.

12. Divide £467, 18s. 6d., in the ratio of ⅓, ¼, and ⅕.

13. A troy lb. of sterling gold consists of 22 carats of pure gold and 2 of alloy, and is coined into 46·725 sovereigns; what quantity of each is there in £724, 4s. 9d.?

14. A troy lb. of sterling silver consists of 37 parts of pure silver and 3 of alloy, and is coined into 66s.; what quantity of each is there in 1023s.?

15. Gunpowder consists of 74·8 parts of nitre, 13·3 of charcoal, and 11·9 of sulphur; how much of each will be required to make 17 cwt. 3 qr. 12 lb. of gunpowder?

16. Divide £266, 17s. 6d. among A, B, and C, giving A 2 as often as B 3, and C 5 as often as B 4.

COMPOUND FELLOWSHIP.

Rule. Multiply each person's stock by the time of its continuance; then state, as the *sum* of the products is to each particular product, so is the gain or loss to each person's share of it.

Ex.—A and B enter into partnership; A put in £500 for 8 months, and B £400 for 12 months; they cleared £158, 8s.: what is the share of each?

Here, (£500 × 8) + (£400 × 12) = £8800, sum of proportionals.

Hence, £8800 : £4000 : : £158, 8s. : £72, 0s. A's share.
8800 : 4800 : : 158, 8 : 86, 8 B's share.
Shares of A and B, £158, 8s. Proof.

17. A's stock of £250 was 3 months in trade, B's of £960 was 2 months, and C's of £540 was 6 months in trade; they gained £480; required their shares.

18. A, B, and C had a joint stock of £630; A's continued only three months, B's 5 months, and C's a year; also, A's stock was £215, B's £310, and C's the rest; they gained £254: required their shares.

19. A and B enter into partnership for a year; A with £200, and B with £160; after 4 months they admit C with £120; at the end of the year their gain is £150; what is each man's share of it?

20. A, B, and C enter into company; A puts in £600, but after 8 months he withdraws £200; B puts in £400, and after 6 months £200 more; C puts in £300, after 4 months £400 more, but at the end of 10 months he takes out £200; they clear £360; required their shares.

21. Three graziers rent a grass field at £30 a-year; A puts in 40 oxen for 4 months, B 60 oxen for 3 months, and C 20 oxen for the rest of the year; what part of the rent ought each to pay?

22. A advances next year £12, and puts in 30 oxen; B pays £10 for 40 oxen; and C the rest for 25 oxen; required the time the oxen of each continued at grass.

NOTE. The proportionals are here found by dividing the sum each paid by the number of oxen he put into the field; thus, A's proportional is $12 \div 30 = \frac{2}{5}$; B's $10 \div 40 = \frac{1}{4}$.

23. A common, containing 595 ac. 1 ro. 16 per. is to be divided among 4 persons, whose estates on which their shares are adjusted are, £6000, £6400, £7000, £7560, per annum, while the value of the land allotted to each is 48s., 50s., 56s., and 60s. per acre; how much land should each receive?

24. A battery of 6 guns has to keep up its fire during 28 hours, another of 4 guns during 24 hours, a third of 3 guns during 20 hours, and a fourth of 2 guns during 15 hours; 3894 rounds are distributed among them; how many rounds should be allotted to each battery?

25. A and B rent a park for £45, 3s. for 8 months; A put in 6 oxen for 3 months and paid £18, 18s.; how many oxen should B, by paying the balance, put in for the rest of the time?

26. Four merchants gain £761, 2s. 2d., of which A's share was £210, 16s. 8d., B's £221, 7s. 6d., C's £177, 2s., and D's the rest; A's stock of £4000 continued 5 months, B's 6 months, C's 7 months, and D's 8 months; required the stock of each.

EXCHANGE

Is the method of converting the money of one country into that of another, according to a given rate.

The par of exchange is the intrinsic value of the money of one country compared with that of another, and is determined by the weight and fineness of their coins.

The course of exchange, which is continually varying, is the present value allowed for a fixed piece of the money of one country estimated in the money of another.

In some countries, money is distinguished into *banco* and *currency*, or *specie* and *paper money*, the former being more valuable than the latter. The difference, reckoned at so much per cent., is called *agio*, *discount*, or *premium*.

The computations in Exchange are performed by Proportion or Practice.

TABLES OF FOREIGN MONEYS.

Austria.—100 new kreuzers = 1 florin or gulden = 1s. 11¾d. sterling; 10 florins 36 kr. = £1 sterling.

Canada and United States.—100 cents = 1 dollar = 4s. 1¼d. sterling; 4·86⅔ dollars = £1 sterling.

Denmark, Norway, and Sweden.—100 örer = 1 krone = 1s. 1⅓d. sterling; 18¼ kroner = £1 sterling.

France, Belgium, Italy, and Switzerland.—100 centimes = 1 franc = 9½d. sterling; 25 fr. 22 cents. = £1 sterling.

German Empire.—100 pfennige = 1 mark = 11¾d. sterling; 20 marks 42½ pf. = £1 sterling.

Holland.—100 cents = 20 stivers = 1 florin or guilder = 1s. 8d. sterling; 12 florins = £1 sterling.

India.—192 pice = 16 annas = 1 rupee (silver) = 1s. 10½d. sterling; a lac is 100,000 rupees; a crore = 100 lacs.

Portugal.—1000 reas = 1 milrea = 4s. 5½d. sterling; a conto = 1000 milreas.

Russia.—100 copecs = 1 ruble (silver) = 3s. 1½d. sterling; 6 rubles 40 copecs = £1 sterling.

Spain.—100 centesimos = 4 reals = 1 peseta = 9½d. sterling; 5 pesetas = 1 duro or dollar = 4s. sterling nearly.

[illegible] equivalent to £[illegible]0.
[illegible] cents per £1?
[illegible] francs 75 cents.
[illegible] equivalent to £47.
[illegible] at 10 florins 36
[illegible]

[illegible] centesimi, and [illegible]
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[illegible] to £375. 14s.
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[illegible] sterling in [illegible] rubles 45 copecs, and in
[illegible]; each at 3[illegible] and at 37[illegible]d., per ruble?
[illegible] sterling in 3703 dollars 70 cents, and in
[illegible]; exchange at 4[illegible] dollars per £1?

17. How much sterling is equal to 17869 marks 70 pf.; exchange at 20 marks 64 pf. per £1?

18. How much sterling in 250 Swiss francs 50 centimes; exchange at 25 francs 25 centimes, and at 25 francs 23 centimes, per £1?

19. Convert £365, 17s. 6d. into rupees, exchange at 1s. 7½d., and 1s. 8d., per rupee.

20. Convert £475, 13s. 4d. into Danish money, when the course of exchange between London and Copenhagen is 18 kroner 45 örer for £1 sterling.

21. A merchant in London owes another in Hamburg 12738 marks 75 pf.; how much sterling money will be required to pay this sum, when the course of exchange is 20 M. 64 pf. for £1 sterling?

22. A party visit Paris, and take with them £250; they convert this into francs when the course of exchange between London and Paris is 25 francs 36 cts. for £1 sterling; their expenses during their stay amounted to 5706·75 francs, and they converted the rest into sterling money when the course of exchange was 25 fr. 33 cts. for £1: with how much sterling money did they leave Paris?

ARBITRATION OF EXCHANGE

Is the method of finding a proportional rate of exchange between *two* places through some other intermediate place or places. When there is only one intermediate place, it is said to be *simple*, when two or more, *compound;* compound arbitrations are rare.

Ex.—When the exchange between London and Madrid is 50d. for 1 duro, and between Leghorn and Madrid 5·60 lire for 1 duro; what is the arbitrated rate between London and Leghorn? Ans. 26 lire 88 cents. for £1.

Antecedents.	Consequents.
Lire ?	= 240d.
50d.	= 1 duro.
1 duro	= 5·60 lire.
	5)134·40 lire.
£1	= 26·88 lire.

Here, the terms are arranged as antecedents and consequents, the first consequent being the term whose value is required; the first antecedent is of the same name as the first consequent, and its value is written as the second consequent, and so on; then the product of the consequents divided by that the antecedents (after cancelling) is the required value.

1. If 6 yards of Hamburg are equal to 5 in Holland, and 7 in Holland = 4 in France, and 5 in France = 5 in England; how many yards English will = 1176 yards of Hamburg; and how many yards of Hamburg will = 100 yards English?

2. If the exchange between London and Holland be 11 fl. 80 cents per £1, and between Holland and Hamburg 59 florins for 100 marks; what is the arbitrated rate between London and Hamburg?

3. If London exchanges with Hamburg at 20·4 marks per £1, and Hamburg with Holland at 100 marks for 58¾ fl.; what is the rate between London and Holland by arbitration?

4. If London exchanges with Holland at 11 fl. 79 c. per £1, Holland with Hamburg at 60 florins for 100 marks, and Hamburg with France at 81 marks for 100 francs; what is the arbitrated rate between London and France?

5. Amsterdam exchanges on London at 11 fl. 56 c. per £1, and on Paris at 47·6 florins for 100 francs; how ought the exchange to go between London and Paris?

6. Paris remits to London 14994 francs, by way of Hamburg, at 122½ francs for 100 marks, thence to Amsterdam at 170 marks for 100 florins, and thence to London at 12 florins for £1; how much will be received in London?

7. If £1 be worth 25·32 francs, 26 francs equal 10 rubles, and 1 ruble equal 2·15 marks; how many marks should be received for £1300?

8. If the rent of one hectare of land in France be 156 francs, and 100 hectares be equal to 247 acres; what is the rent per acre in sterling money when £1 is equal to 25 francs?

9. The first of five boys writes 4 lines in the time that the second writes 2 lines, the second 4 lines in the time the third writes 3 lines, the third 5 lines in the time the fourth writes 4 lines, and the fourth 3 lines while the fifth writes 5 lines; how many lines will the fifth write for each 240 lines that the first writes?

10. If 3½ lb. of coffee = 2 lb. of tea, 3 lb. of tea = 5 lb. of butter, 4 lb. of butter = 22 lb. of sugar; how many lbs. of sugar are equal to 63 lb. of coffee?

11. At a game of billiards, A can give B 10 points in 60,

and C 15 points in 60; how many points can B give C in a game of 100?

12. A can do in 1 day as much as B can do in 2 days, B in 4 days as much as C in 3 days, C as much in 5 days as D in 4 days, and D can do as much in 6 days as E can do in 5 days; how long would E take to do as much as A can do in 14 days?

PROMISCUOUS EXERCISES IN EXCHANGE.

1. Leith draws on Canada for £1127, 10s. sterling; how much will pay the draft, exch. at 4s. per dollar?

2. Edinburgh owes Leghorn 3672 lire for a cargo, per the Caledonia; how much sterling does it amount to, exch. at 25 lire 50 centimes per £1?

3. London owes Lisbon 9210 milreas for a cargo of wine, per the Hopeful; how much sterling must London remit to Lisbon, exchange at 56d. per milrea?

4. Amsterdam remits to London 19351 fl. 45 cents, exch. at 11 fl. 96 cents per £1; for what will Amsterdam be credited in London?

5. London received £1500 for 17970 florins due in Holland; what was the rate of exchange?

6. Paris draws on London for 1884 fr. 20 cents., the course of exchange being 25 fr. 22½ cents. per £1; how much sterling will clear the draft?

7. Hamburg owes London 18975 marks; how much sterling must London draw for, the course of exchange being 20 marks 50 pf. per £1?

8. In 4816 marks, how many florins, exchange at 60 florins for 100 marks?

9. What is gained or lost by remitting £1200 sterling to Paris, when the exchange is at 25 fr. 22½ c. per £1, and drawing when the exchange is at 25 fr. 10 c. per £1?

10. London drew on Hamburg for £1700 sterling, when the course of exchange was 20 M. 64 pf. per £1; what was gained or lost by replacing the draft when the exchange fell to 20 marks 40 pf. per £1?

11. Britain drew on Amsterdam for £6000, exch. at 12 fl. per £1, but was obliged to replace the draft when

the exchange was at 11 fl. 75 c. per £1; what was lost or gained on the whole, and how much per cent.?

12. Britain owes Canada £780, 14s. sterling, exch. at 4s. per dollar; how much sterling will pay the draft, when the exch. is 4s. 1⅛d. per dollar?

13. London remitted to Hamburg £5100 sterling, exch. at 20 marks 64 pf. per £1, and drew for the value, exch. at 20 marks 40 pf. per £1; what was gained or lost, and how much per cent.?

14. What is gained or lost by remitting £750 sterling to Spain, exchange at 4s. per duro, and drawing for the value, exchange at 4s. 9d. per duro; and how much per cent.?

15. How much sterling is equal to 7923·5 kroner drawn on Amsterdam, exch. 150 kr. for 100 florins, commission there ¼ per cent., and drawn from Amsterdam on London, exch. at 11 fl. 96 c. per £1?

16. How many kroner are equal to £10,000 sterling, drawn on Hamburg, exch. at 20 M. 56 pf. per £1, com. there ¼ per cent., and drawn from Hamburg on Denmark at 88·64 kr. for 100 M.?

17. D of Hamburg owes E of London 1652 marks; he may order it to be remitted directly, exch. at 20 M. 65 pf. per £1; or by Holland, exch. at 60 florins for 100 M., thence to London, exch. at 12 fl. per £1; which is the cheaper way?

18. Consigned to Leghorn, with orders to remit to London, a cargo which sold for 155400 lire; what sterling will the factor remit, retaining 3 per cent. commission, exch. at 25 lire 90 cents. per £1?

19. A wood merchant in Leith imported from Russia wood to the amount of 8760 rubles; he may order the sum to be drawn directly, exch. at 25d. per ruble; or on Holland, at 126 fl. for 100 rubles, and from Holland on London, at 12·16 florins per £1; or on Hamburg, at 215 M. for 100 rubles, and from Hamburg on London, at 20·40 M. per £1; required the cheapest medium.

20. Edinburgh owes Paris 1500 francs; how much sterling must be remitted to Amsterdam to clear the draft, the course of exchange between Paris and Amsterdam being 214 francs for 100 florins, and between Amsterdam and London, 11 fl. 95 c. per £1?

21. Leith owes in Denmark 45149 kroner, exch. at 18·12 kr. per £1; whether is it cheaper to remit it directly, or by Holland, exchange between Denmark and Holland 150 kr. for 100 fl., and between Holland and London, 11 fl. 96 c. per £1, commission in Holland ½ per cent.?

22. A of Paris draws on B of London for 24000 francs, exch. at 25 fr. 30 c. per £1; B draws on A for the value, exch. at 25 fr. 20 c. per £1, retaining ½ per cent. commission: what did A gain or lose by this transaction?

23. A of Edinburgh draws on B of Amsterdam for 7896 florins, at 11 fl. 90 c. per £1; B draws on C of London for the value, commission ½ per cent., exch. at 12 fl. per £1; A remits a bill for the value, allowing ½ per cent. commission, for which he pays ½ per cent. exchange: required the gain or loss.

24. A merchant in Edinburgh owes 1751 M. in Hamburg; he may order it to be drawn on London, exch. at 20·60 M. per £1; or on Holland, exch. at 59·5 fl. for 100 M., commission there ½ per cent., exch. from Holland on London, 11 fl. 90 c. per £1: required the cheaper way.

25. A of Vienna owes B of London 4199 florins; he may remit it directly, at 11 fl. 90 kr. per £1; or through Holland, exch. at 97·5 fl. for 100 Neth. fl., commission there ½ per cent., and exch. to London at 12 florins per £1; or through Hamburg, exch. at 57 fl. for 100 M., commission there ½ per cent., and exch. to London at 20·40 M. per £1: required the cheapest medium.

26. E of Edinburgh drew on H of Holland 4800 florins, when the course of exchange was 12 florins per £1, at three months' date; at the end of which time H re-drew on E for the value, retaining ½ per cent. commission, at 1 month's date, exch. at 11 fl. 9 c. per £1: required E's loss or gain, allowing interest at 5 per cent.

27. Consigned to my factor in Oporto, 86 pieces of linen, each 22¾ yards, at 16½d., and 54 pieces, each 30 yards, at 14d.; he advises the sales at 713 and 624 reas per yard, and that he has shipped in return 15 pipes of wine; amount per invoice, 1470 milreas: allowing him 3½ per cent. commission, how much do I gain upon the whole, if, besides clearing freight and charges, I dispose of the wine at a profit of 10 per cent., exch. at 56d. per milrea?

ALLIGATION

Is the method of mixing simples of different qualities, so as to form a mixture of an intermediate quality, and is either *medial* or *alternate*.

ALLIGATION MEDIAL

Is the method of finding the rate of the mixture, when the quantities and rates of the simples are given.

Rule. Multiply each quantity by its rate, and divide the sum of the products by the sum of the quantities.

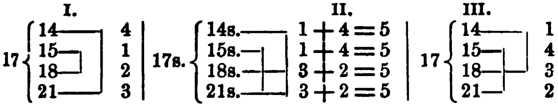
1. Eight lb. of sugar, at 4d. per lb., were mixed with 5 lb. at 5d., and 7 lb. at 8d.; what was the price of the mixture per lb.?
2. Eight lb. of tea, at 3s. 4d., were mixed with 12 lb. at 4s., and with 16 lb. at 4s. 8d.; required the value of a lb. of the mixture.
3. Seven gallons of brandy, at 6s. 3d., are mixed with 9 gallons at 7s. 6d., 12 gallons at 7s. 11¾d., and 4 gallons at 10s. 3d.; what is the mixture worth per gallon?
4. Nine gallons of wine, at 5s. 4d., are mixed with 8 gallons at 6s. 8d., 8 gallons at 7s. 7d., and with 3 gallons of water; what is the value of the mixture per gallon?
5. A wine merchant mixes 18 gallons at 3s. 6d., with 12 gallons at 5s. 7d., and 16 gallons at 4s. 4d.; at what must he sell the compound to gain 10 per cent.?
6. Having melted 6 oz. of gold 22 carats with 12 oz. 18 carats fine, and 18 oz. 15 carats fine; what is the fineness of the composition?

ALLIGATION ALTERNATE

Is the method of finding the quantity of each simple, when the rates of the mixture and the simples are given.

Rule. Write the rates of the simples under each other, with the mixture-rate on the left hand; link the rates of the simples, so that one less than the mixture-rate shall always be linked with one that is greater; write the difference between the mixture-rate and that of each of the simples opposite to that rate with which it is linked: these differences, or their sum, if more than one, will be the quantities at the rates opposite to which they stand.

Ex.—How much whisky at 14s., 15s., 18s., and 21s. per gal. should be mixed, that the compound may be worth 17s. per gal.? ANS. Equal quantities of each.



Here, three solutions are given; the *second* shows that any *equal* number of gallons at the four simple rates will give a mixture worth 17s.

7. How much corn, at 2s. 6d. per bushel and 3s. 4d. per bushel, must be mixed together, that the compound may be worth 3s. per bushel?

8. How much tea, at 3s. and 2s., must be mixed together to form a composition worth 2s. 6d.?

9. How much sugar, at 4d., 6d., and 9d., must be mixed together, that the composition may be worth 8d.?

10. How much wine, at 4s., 5s., 6s., and 8s., must be mixed together, that the compound may be worth 7s.?

11. How much spirits at 18s. per gal. and water should be mixed, to form a mixture worth 15s. per gal.?

12. The men employed at a manufactory receive 2s. 6d. each per day, the women 2s., the boys 1s. 3d., and the girls 9d.; the average of the whole is to be 1s. 10d. each per day; how many of each may be employed?

NOTE 1. When the mixture is limited to a certain quantity. State, as the sum of the quantities, found as above, is to the given quantity, so is each of the quantities found to the required quantity of each.

13. How much brandy, at 4s., 5s., and 6s. per gallon, must be mixed together to form a composition of 24 gallons, worth 5s. 6d.?

14. How much snuff, at 4s., 6s., and 9s. per lb., must be mixed together to form a mixture of 40 lb., worth 7s. per lb.?

15. How much gold 22, 18, 15, 12, and 9 carats fine must be mixed to form a mixture of 25 oz. 17 carats fine?

16. How much fine gold at 84s. per oz., silver at 5s. 6d. per oz., and copper considered as of no value, must be melted, to form a mass of 65 oz. worth 66s. per oz.?

Note 2. When one of the simples is limited.

State, as the quantity of that simple found by the rule is to the limited quantity, so are the other quantities found to the required quantity of each.

17. How much wine, at 4s., 6s., and 7s. per gallon, must be mixed with 6 gallons, at 5s. per gallon, that the mixture may be worth 5s. 6d. per gallon?

18. How much corn, at 7s., 9s., and 10s. per bushel, must be mixed with 6 bushels, at 8s. per bushel, that the mixture may be worth 8s. 6d. per bushel?

19. How much brandy, at 5s., 5s. 6d., and at 6s. per gallon, must be mixed with 3 gallons, at 4s. per gallon, that the compound may be worth 5s. 4d. per gallon?

20. How many lbs. of apples at 2d., 3d., 4d., 6d., and 7d. per lb. should be mixed with 12 lbs. at 5d., that a lb. of the mixture may be sold for 5½d.?

POSITION

Is the method of finding the correct answer to a question by assuming one or two other numbers to be so.

Position is either Single or Double; *Single*, when the question is solved by *one* assumption; *Double*, when solved by *two*.

SINGLE POSITION.

Ex.—What number is that, which if increased by ½, ⅓, and ⅕ of itself, the sum is 427? Ans. 210.

Here, assume any convenient number as 150 to be the answer, and perform upon it the operations indicated in the question; thus, 150 + ½ of 150 + ⅓ of 150 + ⅕ of 150 = 305, but this should be 427; therefore 305 : 427 : : 150 : 210, the number, for 210 + ½ of 210 + ⅓ of 210 + ⅕ of 210 = 427.

1. What number is that, to which if the half, the third, and the fourth of itself be added, the sum will be 125?

2. A jockey being asked the value of his horse, said,

that if from his value you take $\frac{1}{3}$ and $\frac{1}{4}$ thereof, the remainder will be £15; what did he value his horse at?

3. A man being asked his age, said; if to my age you add $\frac{1}{3}$, $\frac{1}{4}$, and $\frac{1}{6}$ thereof, the sum will be 63; find his age.

4. Required a number to which $\frac{1}{3} + \frac{1}{4}$ of itself being added, and $\frac{1}{5}$ of the sum subtracted, there remains 76.

5. The number of fruit-trees in a garden was 252; there were $\frac{1}{3}$ more apple-trees than pear-trees; the number of plum-trees was $\frac{4}{5}$ of the pear-trees, and the cherry-trees were $\frac{4}{3}$ of the plum-trees; how many were there of each?

6. At the end of 5 years a sum of money amounted to £656, 5s. at 5 per cent.; what was the sum?

7. Divide £153, 17s. among 3 persons, giving the second $\frac{5}{8}$ of the first, and the third $\frac{4}{5}$ of the second.

8. How many men were in that army, whereof $\frac{1}{7}$ was killed in battle, $\frac{1}{9}$ taken prisoners, $\frac{1}{10}$ died from sickness, $\frac{1}{21}$ on leave, and only 18850 effective men remained?

9. Divide £718, 4s. among 4 persons, so that their shares multiplied by 3, 4, 5, and 6 respectively may give the same result.

DOUBLE POSITION.

Ex.—A person bought 30 gallons of whisky for £23, 5s.; part cost 15s. per gal., and the rest 17s. 6d.; what was the number of each? Ans. 24 at 15s., 6 at 17s. 6d.

Here, assuming 12 gal. at 15s. and 18 at 17s. 6d., the 30 gal. $=$ 495s. and 495s. $-$ 465s $= +$ 30s. first error. Again, assuming 25 at 15s. and 5 at 17s. 6d., the 30 gal. $=$ 462½s. and 465s. $-$ 462½s. $= -$ 2½s. second error. Then as the difference of the errors is to the difference of the assumptions, so is either of the errors to the error of its assumption; *i.e.*, $(2\frac{1}{2} + 30) : (25 - 12) :: 30 : 12$ error of first assumption, and as there were too few at the cheaper rate, the answer is 24 gal. at 15s., and, therefore, 6 gal. at 17s. 6d.

NOTE 1. When one of the errors is + and the other —, their difference is obtained by adding them.

10. What number is that, which when doubled, and 16 added to the product, will make the sum 56?

11. Three men, A, B, and C, have £36 to be divided

among them, so that B's share is £4 more than $\frac{2}{3}$ of A's, and C's £5 more than $\frac{3}{4}$ of B's; required their shares.

12. What number is that, which being multiplied by 7, and lessened by 30, if the remainder be divided by 5, the quotient will be the same as the required number?

13. A person mixes 60 gallons of wine, part worth 8s. per gallon, and the remainder worth 10s., so that the value of the mixture is 8s. 10d.; required the quantity of each.

14. A person having a certain number of crowns, said, if $\frac{1}{6} + \frac{1}{8} + \frac{1}{9} + \frac{1}{12}$ of what he had were added to 10, the sum would just make 45; required the number of crowns.

15. A gentleman relieving some beggars, found, that if he gave each 4d. he would have 8d. left; but if he gave each 5d. he would have 4d. too little; how many beggars were there?

16. A man sold a horse for £24, and gained as much per cent. as the horse cost; what was the buying price?

17. A workman was engaged for 24 days at 2s. 9d. per day; for every day during which he was idle he forfeited 1s., and had only £1, 12s. 3d. to receive: how many days was he idle?

NOTE 2. By Double Position, any root of a number may be *approximately* obtained.

INVOLUTION

Is the method of finding the powers of numbers.

The number itself is the *first power*, or it is the *root* of that power to which it is to be raised. If it is multiplied once into itself, the product is its *square* or *second power*; if twice into itself, its *cube* or *third power*, and so on.

Powers of numbers are often indicated by writing the number *once*, with a small figure called the *index* or *exponent* of the power, a little to the right above the number, showing how often the number is to be multiplied into itself, thus;

$3^2 = 3 \times 3 = 9$, is the *second* power or *square* of 3.
$3^3 = 3 \times 3 \times 3 = 27$, is the *third* power or *cube* of 3.
$3^6 = 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 729$, is the *sixth* power of 3.
$(\frac{2}{3})^6 = \frac{2 \times 2 \times 2 \times 2 \times 2 \times 2}{3 \times 3 \times 3 \times 3 \times 3 \times 3} = \frac{64}{729}$, is the *sixth* power of $\frac{2}{3}$.

TABLE OF POWERS OF THE NINE DIGITS.

1st. power, or root,	1	2	3	4	5	6	7	8	9
2d. power, or square,	1	4	9	16	25	36	49	64	81
3d. power, or cube,	1	8	27	64	125	216	343	512	729

NOTE. The sum of the indices of powers of the same number is the index of their product; thus $3^4 \times 3^2 = 3^{4+2} = 3^6 = 729$; also $(\frac{1}{5})^3 \times (\frac{1}{5})^2 = (\frac{1}{5})^{3+2} = (\frac{1}{5})^5 = \frac{1}{3125}$.

1. Find the square of 23; 125; $13\frac{1}{3}$; $\frac{7}{9}$; $12\frac{1}{2}$; ·0075.
2. Find the cube of 15; 27; $42\frac{1}{4}$; $\frac{4}{5}$; ·125; ·00625.
3. Raise 31^5; $·4^6$; $(\frac{3}{5})^7$; $(·025)^4$; $(\frac{5}{8})^6$; $(2·25)^3$.
4. The lineal side of a square table was 38 inches; how many square inches did it contain?
5. The lineal side of a stone of a cubic form measures 5 feet; how many cubic feet does it contain?
6. How many $\frac{3}{8}$ inch cubes can be got from a 9 inch cube?
7. A cubic foot of water weighs 1000 oz.; what weight of water will a cistern 6 ft. in the side contain?
8. How many gallons, each $277\frac{1}{4}$ c. in., does a cistern 6 ft. 6 in. in the side contain?

EVOLUTION

Is the method of finding the root of a given power.

The *second* or *square root* of a number is such that when multiplied by itself, the given number is produced, thus; $\sqrt{49} = 7$ for $7 \times 7 = 49$; the *third* or *cube root* of a number is such that when multiplied by its square, the given number is produced, thus; $\sqrt[3]{729} = 9$ for $9 \times 9^2 = 729$. The sign $\surd$ placed over a number shows that its square root is to be extracted; $\sqrt[3]{}$, that its cube root is to be taken; $\sqrt[6]{}$ that its sixth root is to be extracted.

EXTRACTION OF THE SQUARE ROOT.

RULE 1. Divide the number into periods of two figures each, beginning at the place of *units*.

2. Find the greatest square contained in the left-hand period, and place its root on the right, then subtract its

square from that period, and to the remainder annex the second period for a dividend.

3. Place twice the root found for a partial divisor, by which divide the dividend, omitting the right-hand figure; place the result both in the root and on the right of the divisor; then multiply the divisor thus completed by this figure, and subtract the product from the dividend, and to the remainder annex the next period for a new dividend.

To the completed divisor add the figure last placed in the root, for a new divisor, with which proceed as before.

Ex.—Required the square root of 331776. Ans. 576.

	$\dot{3}3\dot{1}7\dot{7}6$	(576 root.
	25	576
107)	817	3456
7	749	4032
1146)	6876	2880
	6876	331776 = square of 576

Note 1. If there is a remainder after all the periods are used, the root may be continued decimally by annexing periods of *two* ciphers to each remainder.

Note 2. Any figure of the root is an integer, or a decimal, according as the period from which it arises is an integer or decimal.

Note 3. The root of a fraction is found by taking the roots of its terms, if it can be done exactly; if not, the fraction must be reduced to a decimal, and its root taken.

Find the Square Roots of,

1.	576	8.	5·875	15.	$\frac{49}{144}$; $\frac{81}{121}$
2.	20736	9.	487683	16.	$\frac{3}{4}$; $\frac{529}{1296}$
3.	622521	10.	914874	17.	·000729
4.	788544	11.	6154346	18.	784·375
5.	1234321	12.	5; 11	19.	$68{\cdot}\dot{3}$
6.	95023504	13.	17·3056	20.	$486{\cdot}\dot{1}$
7.	·5329	14.	·8281	21.	·00000784

22.	5013914481	25.	250403162409
23.	·000000005329	26.	65131436864025
24.	1002003002001	27.	152415787501905 21

mean proportional between two given numbers
t of their product.

28. Find a mean proportional between 4 and 36; 42¼ and 4; 16 and 9; 52$\frac{1}{12}$ and 12; 7 and 135; 2·16 and ·75.

NOTE 2. The side of a square equal in area to any given surface is the square root of the given area.

29. The area of a circle is ·7854; required the side of a square equal in area thereto.

30. A gentleman has a fish-pond, in the form of a triangle, containing 480 perches; he wishes another of equal area, in the form of a square; required its side.

31. A plantation of an irregular form, contains 6400 perches, another of a square form is wanted 3 times as large; required the length of its side.

32. A clergyman's glebe consists of 4 fields; the first contains 2 acres 3 roods 4 per.; 2d, 3 ac. 1 ro. 20 per.; 3d, 1 ac. 15 per.; 4th, 4 ac. 3 ro. 24 per.; he wishes a square field in exchange, equal in area to all the four; required the length of its side.

33. A gentleman has 2 fields; the 1st contains 7 acres 2 roods 8 per.; the 2d, 5 acres 2 roods 24 per.; he wishes to exchange them for a square field of inferior quality, but one-half larger; find the side of the square.

34. In a square plantation, containing 74529 trees, the trees are 18 feet distant; required the length of the side.

35. There are 2 circular walks in a gentleman's pleasure-ground; the diameter of the one is 60 yards, and the other is 5 times as large; required its diameter.

NOTE 3. Circles are to each other as the squares of their diameters.

36. A maltster has a kiln 20 feet in diameter, which is too little by seven-fifths for his business; what is the diameter of one which will suit his purpose?

37. The paving of a circular space 50 feet in diameter costs £74, 16s. 8d.; what will the paving of another, 120 feet in diameter, cost?

38. I planted 6512490 trees in a grove, whose length was 10 times its breadth; required the number of trees in its length and breadth.

39. A gentleman has 2 elliptical ponds; the area of the one is 3 acres, 2 roods,—the other 1 acre, 2 roods, 20 per.; he wishes a square canal 3 times as large as both; required the length of its side.

NOTE 4. In a right-angled triangle, the square of the hypothenuse, or longest side, is equal to the sum of the squares of the other two sides.

40. The three sides of a right-angled triangle are 3, 4, and 5, any *two* of them being given; required the other.

41. The length of a line stretched from the top of a steeple to a station 250 feet from its base, was found to measure 330 feet; find the height of the steeple.

42. Standing on the side of a river, I found that a line stretched from the top of a precipice, rising perpendicularly 449 feet on the other side, measured 585 feet; required the breadth of the river.

43. The wall of a fortification is 248 feet high, the breadth of a ditch surrounding it is 224 feet; required the length of a scaling-ladder that will reach from the farther side of the ditch to the top of the wall.

44. Two men travelled from the same place, the one north 25 miles per day, the other west 32 miles; how far were they distant after travelling 5 days?

45. In a straight line between 2 trees stands a statue, that part of it which is level with the foot of the trees is just 90 feet from the top of each; the one tree is 54 feet, the other 60 ft. high; find the distance between the trees.

46. Arrange 39605 men, so that the number in front may be 5 times the number in the side.

47. The wages of a certain number of men amount to £7776, at 3s. 4d. a-day; they worked as many days as there were men employed; how many men were there, and how much did each receive?

48. The side of a square is 30 ft.; what is its diagonal?

49. The diameter of the base of a cone is 24 ft., and its slant height is 25 ft.; required the perpendicular height of the cone.

50. What are the length and breadth of an oblong 5 times as long as it is broad, whose area is 4 acres?

EXTRACTION OF THE CUBE ROOT.

RULE 1. Divide the given number into periods of three figures each, beginning at the place of *units*.

2. Find the greatest cube in the left-hand period, place its root on the right, and take its cube from that period; then to the remainder annex the second period for a dividend.

3. Multiply the square of the figure in the root by 300 for a partial divisor, and divide the dividend by it for the next (trial) figure of the root. To the former figure of the root add its double, and to the sum annex the trial-figure; then multiply by this figure, and place the product below the divisor. Multiply the sum of these two by the trial-figure, then subtract the product from the dividend, and to the remainder annex another period for a new dividend; if the product is greater than the dividend, a less trial-figure must be taken, and used as before.

4. Below the complete divisor set the square of the figure last placed in the root; add it and the two lines above it, and to the sum annex two ciphers for a new partial divisor.

5. With this divisor find another figure and place it in the root; to the number on the right that was multiplied by the last figure add the double of that figure, and to the sum annex the new trial-figure; next multiply it by the trial-figure, and place the product under the divisor, then proceed as before.

Ex.—Find the cube root of 78567733187. Ans. 4283.

```
                                   78567733187 ( 4283 cube root.
 4² × 300 = 4800                   64             8
                                  ---------      ----
122  × 2  =  244 \                ) 14567         122 × 2
            -----  |                                4
             5044  > × 2 =           10088         ----
                4 /                ) 4479733      1268 × 8
            ------                                  16
           529200                                 -----
1268 × 8  =  10144 \                              12843 × 3
            ------  |
           539344   > × 8 =   4314752
               64  /          ---------
           --------
         54955200            ) 164981187
12843 × 3  =  38529
         --------
         54993729 × 3 =    164981187
                           =========
```

Note. The root may be carried on decimally by annexing periods of *three* ciphers to each remainder.

Required the Cube Roots of,

1. 15625
2. 21024576
3. 52734375
4. 490982336369
5. 1371737997260631
6. 67459354004042485129
7. 219365327791
8. 34423760853151212161929
9. ·041063625
10. 484846678016
11. 6784
12. 7835·8748
13. 3; 7
14. ·000000091125
15. 784·67341688
16. 70846
17. ·00091855945728
18. $\frac{216}{343}$, $\frac{125}{729}$, $\frac{1728}{2197}$
19. 27081892655918127

Note 1. The side of a cube equal in solidity to any given solid, is the cube root of its solid content.

20. The solidity of a sphere is 11390·625; required the lineal side of a cube of equal solidity.

Note 2. Similar solids are to each other as the cubes of their diameters, sides, etc.

21. The lineal side of a cubic piece of marble measured 36 feet; required the side of a piece 6⅛ times as large.

22. A mound of earth is 660 ft. long, 120 ft. broad, and 208 ft. deep; required the side of a cubic one equal to it.

23. If a globe of 8 inches diameter weighs 18 lb.; what will be the diameter of another weighing 162 lb.?

24. The length of a rectangular cistern is 4 feet, breadth 3 feet 4 inches, and depth 30 inches; required the dimensions of another three times as large.

25. A ball, 12 inches in diameter, weighs 30 lb.; what will a ball weigh whose diameter is 28 inches?

26. A ball, 16 inches in diameter, weighs 56 lb.; what will be the diameter of another, which weighs 12 times as much?

27. The length of a stone is 8 feet, its breadth 6 feet, and its thickness 4 feet; what are the dimensions of another 10 times as large, and also the side of a cube equal to both?

Higher Roots.—The *fourth* root of a number is obtained by two extractions of the square root; the *sixth* root by taking the square root, and then the cube root of the result, and so on.

EXTRACTION OF ANY ROOT.

Rule 1. Divide the given number into periods of as many figures as there are *units* in the name of the root.

2. Find the power nearest to the left-hand period, whether greater or less than it, and take the difference between it and the given number, reckoning it all decimals except the first period, then multiply it by the root of the assumed power for a dividend.

3. Add *one-half* of the difference to the given number if it be *less* than the assumed power, *otherwise* subtract, and multiply the sum or remainder by the name of the root lessened by 1; the product added to the assumed power is a divisor, by which divide the dividend, for the difference between the root found and that required, nearly.

4. The root may be found still more accurately by repeating the operation, using the root now found and its power.

Ex.—Required the 4th root of 2. Ans. 1·189208.

The nearest root is 1·2, of which the 4th power is 2·0736, the assumed power.

```
2)·0736                     2·0736  assumed power.
  ·0368                     2·0000
 2·0000                     ·0736 × 1·2
 2·0368 × 3         8·184 ) ·08832 (    ·010792
 6·1104                       64800  1·189208 root.
 2·0736                        75120
 8·184                          14640
```

Repeating the operation, and using 1·189208 for the assumed root, and its 4th power 2·000006, for the assumed power, the next correction is ·0000008919043277; which, subtracted from the root found, gives 1·1892071080956723, etc., for a nearer approximation, and so on.

Required the

1. 4th root of 97·41.
2. 5th root of 3.
3. 5th root of 33554432.
4. 4th root of 5308416.
5. 3d root of 7854.
6. 6th root of 21035·8.
7. 4th root of 7.
8. 5th root of 9.
9. 6th root of 5.
10. 3d root of ·000485613
11. 6th root of 19110297.
12. 5th root of 10.
13. 7th root of $\frac{1}{3}$.
14. 5th root of $\frac{5}{12}$.
15. 7th root of 19.
16. 6th root of 43·375

SERIES OR PROGRESSIONS.

An Arithmetical Progression, or Equidifferent Series, is a rank of numbers, uniformly increasing or decreasing, by the constant addition or subtraction of some number called the *common difference;* thus, 1, 2, 3, 4, 5, is an increasing arithmetical series, whose common difference is 1; and 10, 8, 6, 4, 2, is a decreasing A. P., whose common difference is 2.

A Geometrical Progression, or Equirational Series, is a rank of numbers, uniformly increasing or decreasing, by a constant multiplier called the *common ratio;* thus, 1, 2, 4, 8, is an increasing geometrical series, whose common ratio is 2; and 27, 9, 3, 1, is a decreasing G. P., whose common ratio is $\frac{1}{3}$.

The first and last terms of a series are called the *extremes*, and the other terms the *means*.

ARITHMETICAL PROGRESSION.

Of the two extremes, common difference, number of terms, and sum of the series, any *three* being given, the other two may be found.

Theorem. The sum of the extremes is equal to the sum of any two means equally distant from them; and the double of any term is equal to the sum of any two terms equidistant from it on each side.

Problem I. Given the extremes and number of terms, to find the common difference and sum of the series.

Rule. Divide the difference of the extremes by *one* less than the number of terms for the com. diff.; and multiply the sum of the extremes by *half* the number of terms for the sum of the series.

Ex.—The extremes in an A. P. are 2 and 24, and the number of terms 12; find the common difference and sum of the series. Ans. 2 and 156.

Here, $(24-2)\div(12-1)=22\div11=2$, common difference.
And, $(24+2)\times(12\div2)=26\times6=156$, sum of the series.

1. Given the extremes 12 and 42, and the number of terms 11; required the common difference, and the sum of the series.

2. A person owed a certain sum, which he paid in 13 different payments, in arithmetical progression; the first payment was 3s., the last £2, 11s.; how much did each payment exceed the former, and how much did he owe in all?

3. A farmer bought 100 sheep, and gave for the first 1s., and for the last £19, 17s.; what did he give for the whole, and how much did the price of any one exceed that of the preceding?

Prob. II. Given the extremes and common difference, to find the number of terms and sum of the series.

Rule. Divide the difference of the extremes by the common difference, and add *one* to the quotient for the number of terms; find the sum by Prob. I.

Ex.—The extremes of an A. P. are 3 and 79, and the com. diff. 4; find the number of terms and sum of the series. Ans. 20 and 820.

Here, $(79 - 3) \div 4 (+ 1) = (76 \div 4) + 1 = 19 + 1 = 20$, number of terms.

And, $(79 + 3) \times 10 = 82 \times 10 = 820$, sum of the series.

4. Given the extremes 7 and 103, and the com. diff. 4; required the number of terms and sum of the series.

5. A nurseryman planted a number of firs in the form of an isosceles triangle; he put one plant in the first row, 3 in the second, and so on in A. P.; the last row contained 61 plants; how many rows and plants were there?

6. A person meeting with a number of poor people, gave the first 2d., the second 5d., and so on in A. P. until the last, to whom he gave 2s. 8d.; required the number of poor people, and how much they received in all.

7. A person travelling from one city to another, went 6 miles the first day, 9 the second, and so on in A. P.; his last day's journey was 60 miles; required the number of days he travelled, and the distance between the cities.

Prob. III. Given the common difference, number of terms, and sum of the series, to find the extremes.

Rule. Divide the sum of the series by the number of terms; also multiply half the com. diff. by *one* less than the number of terms; then take the *sum* and *difference* of the results, for the *greater* and *less* extreme.

Ex.—The number of terms of an A. P. is 15, the com. diff. 5, and the sum of the series 630; what are the extremes? Ans. 77 and 7.

Here, $(630 \div 15) \pm (2\frac{1}{2} \times 14) = 42 \pm 35 = 77$ and 7, extremes.

8. Given the number of terms 9, the com. diff. 2, and the sum of the series 135; required the extremes.

9. A person discharged a debt of £210, 12s. in a year, by paying every week 3s. more than he did the preceding; find the first and last payments.

10. A courier by increasing his day's journey 3 miles every day, travels 345 miles in 15 days; required his first and last day's journey,

11. A horse-dealer buys 10 horses for £110, the difference of their prices is £2; what did the first and last cost?

Prob. IV. Given either of the extremes, the common difference, and number of terms, to find the rest.

Rule. Multiply the common diff. by *one* less than the number of terms; the product, added to the less extreme, gives the greater, or, subtracted from the greater, gives the less extreme: find the sum of the series by Prob. I.

Ex.—The greater extreme of an A. P. is 104, the com. diff. 5, and number of terms 21; required the less extreme and the sum of the series. Ans. 4 and 1134.

Here, $104 - (5 \times 20) = 104 - 100 = 4$, first term.
And, $(4 + 104) \times 21 \div 2 = 108 \times 10\frac{1}{2} = 1134$, sum of series.

12. Given the less extreme 12, com. diff. 3, and number of terms 11; find the greater extreme, and sum of the series.

13. Given the greater extreme 123, com. diff. 5, and no. of terms 24; find the less extreme, and sum of the series.

14. A sum of money was divided among 12 persons, whose shares were in A. P.; the first received 3s., the second 7s., and so on: find the sum divided, and the share of the last.

15. A traveller accomplished a journey in 15 days, by travelling each day 3 miles more than the preceding; he travelled 49 miles the last day: how many miles did he travel the first day, and what was the length of the journey?

GEOMETRICAL PROGRESSION.

Theorem. The product of two terms is equal to that of any two equidistant from them; and the square of any term is equal to the product of any two equidistant from it.

Problem I. Given the first term, ratio, and number of terms, to find any term.

Rule. Raise the ratio to a power less by *unity* than the number of the required term, then multiply that power by the first term.

Ex.—Given the first term of a G. P. 4, and ratio 2; to find the 7th term. Ans. 256.

Here, $4 \times 2^6 = 4 \times 64 = 256$, the 7th term.

1. Given the first term of a G. P. 3, and the ratio 2; to find the 8th term.
2. Given the first term 5, and ratio 3; to find the 6th.
3. Find the 5th and 8th terms of the series 2, 6, 18, 54, etc.
4. Find the 6th and 10th terms of the series $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, etc.
5. Find the 3d and 5th terms of the series ·2, ·02, ·002, etc.
6. A merchant bought 12 yards of cloth for the price of the last yard, reckoning 1d. for the first, 2d. for the second, and so on in G. P.; how much did he pay?
7. A farmer bought 15 oxen for the price of the 10th, reckoning 2d. for the first, 6d. for the second, etc.; how much did he give, on an average, for each?

Prob. II. Given the first term, the ratio, and number of terms, to find the sum of the series.

Rule. Raise the ratio to that power whose index denotes the number of terms, and multiply the difference between this and *unity* by the first term, then divide the product by *one* less than the ratio.

Ex.—Find the sum of 8 terms of the G. P. 2, 4, 8, etc.

Here, the ratio is 2, hence, $(2^8 - 1) \times 2 \div (2 - 1) = 255 \times 2 = 510$, the sum of the series.

8. Given the first term of a G. P. *unity*, the ratio 3, and number of terms 8; required the sum of the series.
9. Find the sum of 7 terms of the series, 5, 10, 20, 40, etc.
10. Find the sum of 6 terms of the series, $\frac{1}{5}$, $\frac{1}{15}$, $\frac{1}{45}$,

11. What debt will be discharged in a year by monthly payments, of which the first is 5s., the second 10s., the third 20s., and so on?

12. A gentleman, who had a daughter married on New-year's-day, gave her husband towards her portion 4s., promising to triple that sum on the first day of the nine succeeding months; what was his daughter's portion?

Prob. III. Given the first term, and the ratio in a decreasing G. P., to find the sum of the series *ad infinitum.*

Rule. Divide the *square* of the first term, by the difference between the first and second terms.

Ex.—Find the sum of the infinite series, $\frac{1}{5}$, $\frac{1}{10}$, $\frac{1}{20}$, etc.

Here, $(\frac{1}{5})^2 \div (\frac{1}{5} - \frac{1}{10}) = \frac{1}{25} \div \frac{1}{10} = \frac{1}{25} \times \frac{10}{1} = \frac{2}{5}$, sum.

13. Required the sum of the G. P. $\frac{3}{10} + \frac{3}{100} + \frac{3}{1000}$, etc., *ad infinitum.*

14. Required the sum of $\frac{1}{3} + \frac{1}{9} + \frac{1}{27}$, etc., *ad infinitum.*

15. If a ball be discharged by a force which carries it 10 miles in the 1st minute, 9 miles in the 2d minute, and so on for ever; what distance would it traverse?

16. If a body moves $\frac{7}{10}$ of a mile in the first second, $\frac{7}{100}$ in the second, $\frac{7}{1000}$ in the third, and so on for ever; how far will it go?

17. Find the value of the circulating decimal, ·999, etc.

18. Find the value of the circulating decimal, ·444, etc.

19. Find the value of the repeating decimal, ·833, etc.

20. Find the value of the repeating decimal, ·5833, etc.

PERMUTATIONS AND COMBINATIONS.

Permutations of things are the different orders in which they can be arranged, when taken *singly*, or *two* and *two* together, *three* and *three* together, etc.

Combinations of things are the different groups which can be formed from them, when taken *singly*, *two* and *two* together, *three* and *three* together, etc.

Problem I. To find the number of permutations that can be made of any number of things all different from each other.

Rule. Multiply all the terms of the natural series of numbers, from *unity* up to the given number of things.

Ex.—In how many ways could 7 persons be seated at table? Ans. 5040 ways.

Here, 1 . 2 . 3 . 4 . 5 . 6 . 7 = 5040 ways.

1. How many changes can be rung on 24 bells?
2. How many permutations can be made of the 9 digits?
3. How many permutations can be made of the letters in the word *authorized?*
4. How many days can a company of 12 persons sit in a different position round a table at dinner, and what would the whole expense be, at 32s. 6d. for each dinner?

Prob. II. To find how many permutations can be made of any number of things, of which there are several of one sort, and several of another, etc.

Rule. Divide the product of the natural series from *unity* up to the whole number of things, by the product of *unity* up to the number of the first sort, multiplied by that of *unity* up to the number of the second sort, etc.

Ex.—How many permutations can be made of the letters in the word *Mathematics?* Ans. 4989600 permut.

Here, there are 11 letters in all, of which 2 are *m's*, 2 are *a's*, and 2 are *t's*, hence $\frac{1.2.3.4.5.6.7.8.9.10.11}{1.2 \times 1.2 \times 1.2} = 39916800$ $\div 8 = 4989600$ permutations.

5. How many permutations can be made of the letters in the word *Lammermuirhills?*
6. How many permutations can be made of the letters in the word *beginning?*
7. How many permutations can be made of 3 apples, 3 oranges, and 3 plums?
8. How many numbers can be made of the following figures, 97387793988?

Prob. III. To find the number of permutations that can be made of a number of things all different, when taken 2, 3, 4, etc., at a time.

Rule. Multiply together as many terms of a series, beginning with the number of things and decreasing by *unity*, as there are quantities to be taken at a time.

Ex.—How many permutations can be made of 10 things all different, when taken 4 and 4 together? Ans. 5040.

Here, $10 \times 9 \times 8 \times 7 = 5040$ permutations.

9. How many changes can be made by taking 3 and also 5 digits out of the nine?

10. How many changes can be rung with 5 bells out of 12; 6 out of 8; 8 out of 9?

11. How many permutations can be made with 2 letters out of those in the word *authorized?*

12. How many changes can be made with 5 letters out of the 26 which compose the alphabet?

Prob. IV. To find the number of combinations which can be made of any number of things all different by taking any number at a time.

Rule. Divide the product of a series beginning with the number of things and decreasing by *unity* to the number to be taken together, by that of the natural series from *unity* up to the same number.

Ex.—How many different signals can be made by 12 flags, which can be hoisted 3 at a time, over each other?

$$\text{Here, } \frac{12 . 11 . 10}{1 . 2 . 3} = \frac{1320}{6} = 220 \text{ signals.}$$

13. How many combinations can be made of 8 letters out of 12, 9 out of 15, and 10 out of 21?

14. In how many different ways can a guard of 6 men be taken out of a regiment of 900 men?

15. How many deals may a person play at the game of whist without holding the same cards twice; a pack containing 52 cards, and a hand 13?

16. A general requested, as a reward for his services, a farthing for every file of 10 men which could be taken out of a company of 100; how much does this amount to?

Prob. V. To find the number of combinations which can be made of any number of different things when taken by two's, three's, four's, etc., up to the number of things.

Rule. From that power of 2, which is denoted by the number of things, subtract the number increased by *unity*.

Ex.—How many different sums may be formed with a guinea, a sovereign, a crown, a florin, and a shilling, taken by two's, three's, etc.? Ans. 26 sums.

Here, $2^5 - (5 + 1) = 32 - 6 = 26$ sums.

17. Required all the combinations that can be made of the nine digits, taking them by two's, three's, etc., up to 9.

18. Required all the combinations that can be made of the 26 letters of the alphabet, when taken two by two, three by three, etc., up to 26.

19. Required all the combinations, or conjunctions, that can be made by the 7 moons of Saturn, when taken by two's, three's, etc., up to 7.

20. Required all the combinations that can be made of 52 cards, taking them by two's, three's, etc., up to 52.

Prob. VI. To find all the permutations and combinations that can be made of any number of different things when taken by two's, three's, etc., at a time, up to the given number.

Rule. Raise the given number to such a power as is denoted by the number itself, and multiply the result minus *one*, by the number of things; then divide this product by the given number, minus *one*.

Ex.—Required all the permutations and combinations which can be made of four things when taken by two's, three's, up to 4. Ans. 340.

Here, $(4^4 - 1) \times 4 \div (4 - 1) = 255 \times 4 \div 3 = 340$.

21. Required all the permutations and combinations which can be made of the five vowels, when taken by two's, three's, etc., at a time, up to five.

22. Required all the permutations and combinations which can be made of the 9 digits, when taken by two's, three's, etc., up to 9.

23. Required all the permutations and combinations which can be made of the 21 consonants of the alphabet, taking them two by two, three by three, etc., up to 21.

24. Required all the permutations and combinations which can be made of a suit of 13 cards, taking them by two's, three's, etc., up to 13.

Prob. VII. To find the number of combinations which can be formed of several sets of things, each containing a certain number of things, by taking *one* from each set to form a combination.

Rule. Multiply the number of things in each set continually together.

Ex.—In one company are 7 men, in another are 8 men, in a third are 12 men, and in a fourth are 15 men; in how many ways may 4 men be chosen, one out of each company? Ans. 10080.

Here, $7 \times 8 \times 12 \times 15 = 10080$ ways.

25. In how many ways can the four suits of cards be taken 4 at a time?

26. How many changes are there in throwing 5 dice?

27. There are three parties of card-players, each consisting of 11 persons; in how many ways can 11 of them be chosen, one out of each?

28. There are 7 parties of whist-players, each consisting of 4 persons; in how many ways can they be changed?

COMPOUND INTEREST

Is an allowance not only for the use of the sum borrowed, but also for the use of the interest after it becomes due.

Case I. Given the principal, rate, and time, to find the amount, and the interest.

Rule 1. Find the interest for the first payment, and add it to the principal, then find the interest of the sum for the next payment, and add it to that sum, and so on.

2. Find the amount of £1 for the first payment, and raise it to the power denoted by the number of payments; multiply this power by the principal for the amount: from this result subtract the principal for the interest.

The amount of £1 for five years at 4 p. c. when the interest is payable yearly, is $(1{\cdot}04)^5$; when payable half-yearly, $(1{\cdot}02)^{10}$; when payable quarterly, $(1{\cdot}01)^{20}$.

Ex.—Find the amount of £500 for 7 years, at 4 per cent. per annum, compound interest. Ans. £657, 19s. 3¾d.

Here, $(1{\cdot}04)^7 \times 500 =$ by Table I., p. 172, $£1{\cdot}31593 \times 500 = £657{\cdot}965 =$ £657, 19s. $3\frac{2}{4}$d. amount; and £657, 19s. $3\frac{2}{4}$d. — £500 = £157, 19s. $3\frac{2}{4}$d. interest.

1. Required the amount of £400 for 3 years, at 5 p. cent.

2. Required the amount of £640 for 4 years, at 3 p. cent.

3. Required the amount of £800 for 5 years, at 4 p. cent.

4. Required the amount of £800 for 5 years, at 4 p. cent., the interest payable half-yearly, and also quarterly.

5. What is the compound interest of £500 for 6 years, at 3 per cent., payable yearly?

6. Find the compound interest of £450 for 5 years, at 6 per cent., the interest payable half-yearly.

7. What is the compound interest of £725 for 3 years, at 4 per cent., the interest payable quarterly?

8. Required the compound interest of £840 for 2 years, at 3 per cent., the interest payable three times a-year.

Case II. Given the amount, rate, and time, to find the principal, or present worth.

Rule. Divide the given sum by the amount of £1 for the given time and rate per cent. as found by Case I.

Ex.—Find the present value of £700 due 7 years hence, at 4 per cent. per annum comp. int. **Ans.** £531, 18s. 10d.

Here, $£700 \div (1{\cdot}04)^7 = £700 \div 1{\cdot}31593 =$ £531, 18s. 10d.; or, by Table II., $£{\cdot}759918 \times 700 = £531{\cdot}9426 =$ £531, 18s. 10d.

9. What is the present value of £840 due 8 years hence, at 3 per cent. per annum, compound interest?

10. Find the present value of £210 due 10 years hence, at 5 per cent. per annum, compound interest.

11. What principal will amount to £350 in 10 years at 4 per cent. per annum, compound interest?

12. What sum will amount to £300 in 7 years, at 2½ per cent. per annum, compound interest?

13. What principal put to interest for 5 years, at 5 per cent., will amount to £1280, 10s. 6d.?

14. What principal will amount to £1260 in 10 years, at 4½ per cent.?

15. What principal will amount to £1000 in 4 years, at 4 per cent. per annum, the interest payable half-yearly?

16. What principal will amount to £850 in 2½ years, at 3 per cent. per annum, the interest payable quarterly?

Case III. To find the interest on bonds or bills when payments are made at long intervals.

Rule. Add the interest due at the times of payment to the principal, and from that amount deduct the payment.

Ex.—Borrowed on bond at 4½ per cent., £900 on Jan. 1, 1876, and paid £350 on Mar. 11, 1877; £300 on June 12, 1878, and the balance on Nov. 15, 1879; what was then due? Ans. £353, 5s.

Jan. 1, 1876.	Borrowed at 4½ p. c., .	£900·000
	Interest for 434 days,	48·156
	Amount,	948·156
Mar. 11, 1877.	Paid in part, . . .	350·000
	Balance,	598·156
	Interest for 458 days,	33·776
	Amount,	631·932
June 12, 1878.	Paid in part, . . .	300·000
	Balance,	331·932
	Interest for 521 days,	21·321
	Amount,	353·253
Nov. 15, 1879.	Paid in full, . . .	353·253

17. Lent on bond, June 1, 1874, the sum of £750, at 5 per cent.; of which I received, Oct. 8, 1875, £180; Jan. 1, 1877, £360; and the balance Aug. 14, 1878; how much did I then receive, interest at 5 per cent.?

18. Borrowed on bond, March 18, 1877, £600; of which I paid, July 27, 1878, £250; Nov. 17, 1879, £225; Feb. 24, 1880, £175; the balance is to be paid May 30, 1881; how much will it amount to at 4½ per cent.?

19. Lent to A. B. on bond, Jan. 1, 1875, £1000; of which I received, May 25, 1876, £400; Sept. 3, 1877, £350; and the balance, Feb. 24, 1879; how much did I then receive, interest at 4¾ per cent.?

ANNUITIES.

An annuity is a periodical income payable at equal intervals of time, as yearly, half-yearly, quarterly.

Annuities are called *certain* when the time of their continuance is fixed, *contingent* when the time of their continuance depends upon the probabilities of the duration of human life; when an annuity is to continue for ever, it is called a *perpetuity*. When an annuity is payable immediately, it is said to be *in possession*, but when the payment is not to commence until some fixed period has elapsed, or until the death of a certain person, the annuity is said to be *reversionary* or *deferred*.

The *amount* of an annuity is the sum of all the single payments, each improved at compound interest from the time of its becoming due until the whole is paid.

The *present value* of an annuity is the sum, which at compound interest should be presently paid for it.

Note. In calculating the value of an annuity, the first payment is always considered to be made at the end of the first period from the time of the valuation.

ANNUITIES CERTAIN.

Problem I. To find the amount of an annuity, time and rate of interest being given.

Rule. Find the sum of a geometrical series of the same number of terms as the number of payments, the first term being *unity*, and the ratio the amount of £1 for the first payment; then multiply this result by the given annuity.

Ex.—Find the amount of an annuity of £50, payable yearly for 5 years, at 4 per cent. per annum comp. int.

Here, $(1{\cdot}04)^5 - 1) \div {\cdot}04 \times 50 = £5{\cdot}41632 \times 50 = £270{\cdot}816$, amount; or, by Table III., $£5{\cdot}4163 \times 50 = £270{\cdot}815$, amount nearly the same as before.

1. What is the amount of an annuity of £40, payable yearly for 4 years, at 4 p. c. per an. comp. int.?
2. What will an annuity of £20, payable half-yearly, amount to in 4 years, interest at 4 per cent.?
3. What will an annuity of £10, payable quarterly, amount to in 4 years, at 4 per cent.?
4. What will an annuity of £60 per annum amount to in 10 years, at 5 per cent.?

Prob. II. To find the present worth of an annuity, time and rate of interest being given.

Rule. Find, by last Prob., the amount of the annuity for the given time and rate, then find the present worth of this result (by Case II., Compound Interest), as a sum due at the end of the given time.

Ex.—Find the present value of an annuity of £60, payable yearly for 7 years, at 5 per cent. per annum.

Here, amt. of £1 for 7 ye., at 5 p. c. is $(1{\cdot}05)^7$ = £1·40710; amt. of £1 per an. for 7 years at 5 p. c. = $((1{\cdot}05)^7 - 1) \div {\cdot}05$ = £8·1420; then, (£8·1420 ÷ 1·4071) × 60 = £5·7864 × 60 = £347·184 present value; or, by Table IV., £5·7864 × 60 = £347·184 present value as above.

5. Required the present worth of an annuity of £100 per annum, to be continued 5 years, interest at 5 per cent.

6. Required the present worth of an annuity of £40 per annum, to be continued 20 years, interest at 4 per cent.

7. Required the present worth of an annuity of £80, payable half-yearly, for 6 years, at 4 per cent. per annum.

8. Required the present value of an annuity of £30, payable quarterly, for 5 years, at 3 per cent. per annum.

Prob. III. To find the present worth of an annuity, or the yearly rent of a freehold estate in *reversion*, time and rate of interest being given.

Rule. Find the present worth of the annuity, for the time of its continuance; then find the present worth of this result for the time which must elapse before the commencement of the annuity.

Ex.—Find the present value of an annuity of £90 a-year, to commence 4 years hence, and continue 20 years, interest at 4 per cent. per annum. Ans. £1045, 10s. 7d.

Here, present value of £1 per annum for 20 years, at 4 p. c. by Tab. IV. = £13·5903; and present value of £1 for 4 years, at 4 p. c., by Tab. II. = £·854804; then £13·5903 × ·854804 × 90 = £1045·530, present value.

9. What is the present worth of an annuity of £80, to commence 5 years hence, and to continue 21 years, interest at 5 per cent. per annum?

10. The reversion of a freehold estate of £500 per annum, to continue 20 years, and to commence 10 years hence, is to be sold; what is it worth, allowing the purchaser 5 per cent. per annum for his money?

11. The reversion of a lease of £100 per annum to continue 10 years, but not to commence till the end of 6 years, is to be sold; what is its present worth, interest at 4 per cent. per annum?

12. What is the present worth of an annuity of £50, which commences 12 years hence, and continues 15 years, interest at 3 per cent. per annum?

Prob. IV. To find the present worth of a perpetuity, the rate of interest being given.

Rule. Divide the perpetuity by the interest of £1 for a year.

Ex.—Find the present value of a perpetuity of £75 a-year, interest at 4 per cent. per annum. **Ans.** £1875.

Here, £75 ÷ ·04 = £1875, present value.

13. Required the present worth of a perpetuity of £250 a-year, interest at 5 per cent. per annum.

14. Required the present value of a freehold estate of £500 yearly rent, to continue for ever, interest at 4 p. cent.

15. What is the present worth of a perpetuity of £1200 a-year, payable quarterly, int. at 4½ per cent. per annum?

16. Required the present value of a freehold estate of £6000 a-year, to continue for ever, the rent being payable half-yearly, interest at 5 per cent. per annum.

Prob. V. To find the yearly income, the present value of a perpetuity and the rate of interest being given.

Rule. Multiply the present value by the interest of £1 for a year.

Ex.—A freehold estate was purchased for £4000; what ought the yearly rent to be, interest at 4 per cent.?

Here, £4000 × ·04 = £160, yearly rent.

17. A freehold estate was purchased for £5000; what ought the yearly rent to be, interest at 5 per cent.?

18. Purchased a perpetual annuity for £1000; what ought the annuity to be yearly, interest at 4½ per cent.?

19. What is the annual rent of a freehold estate which cost £2000, reckoning interest at 5 per cent.?

20. What yearly annuity, to continue for ever, can be purchased for £2500, reckoning interest at 4 per cent.?

Prob. VI. To find the rate of interest, the present worth and yearly income of any perpetuity being given.

Rule. Multiply the yearly income by 100, and divide the product by the present worth.

Ex.—Paid £4500 for an estate which yields £135 annually; what is the rate of interest? Ans. 3 per cent.

Here, £135 × 100 ÷ 4500 = 3 per cent.

21. Paid £4166⅔, for a freehold estate, which yields £250 yearly rent; what rate of interest am I allowed?

22. Paid £1000 for a perpetual annuity of £60 a-year; what rate of interest am I allowed for my money?

23. Paid £25000 for a freehold estate, which yields £1000 yearly rent; what rate of interest do I obtain?

24. What rate of interest do I obtain by purchasing a perpetual annuity of £500 a-year for £12000?

Prob. VII. To find the annual rent, the present worth and time in which a freehold estate ought to clear itself being given.

Rule. Divide the present worth by the given time.

Ex.—Purchased a freehold estate for £10000; what should the annual rent be, to clear itself in 20 years?

Here, £10000 ÷ 20 = £500, yearly rent.

25. Purchased a freehold estate for £25000; what should the annual rent be, to clear itself in 15 years?

26. Purchased a freehold estate for £12000; what should the yearly rent be, to clear itself in 20 years?

27. Purchased a freehold estate for £8176, 18s. 9d.; what should the annual rent be, to clear itself in 18 years?

28. Purchased a freehold estate for £15896, 11s. 8d.; what should the annual rent be, to clear itself in 16 years?

Prob. VIII. To find the time in which a freehold estate will clear itself, the present worth and annual rent being given.

Rule. Divide the present worth by the annual rent.

Ex.—The yearly rent of an estate, which cost £10000, is £500; in what time will it clear itself? Ans. 20 years.

Here, 10000 ÷ 500 = 20 years.

29. The annual rent of a freehold estate, which cost £25000, is £1666⅔; in what time will it clear itself?

30. The annual rent of a freehold estate, which cost £8000, is £500; in what time will it clear itself?

31. The annual rent of a freehold estate, which cost £12000, is £666⅔; in what time will it clear itself?

32. The annual rent of a freehold estate, which cost £20000, is £1500; in what time will it clear itself?

Prob. IX. To find the rate of interest, the time in which a freehold estate clears itself being given.

Rule. Divide the time plus *one* by the time; the result is the amount of £1 for one year.

Ex.—A freehold estate is bought at 14 years' purchase; what is the rate of interest? Ans. 7⅐ per cent.

Here, $15 \div 14 = £1{\cdot}0\dot{7}1428\dot{5}$, *i.e.*, 7⅐ per cent.

33. A freehold estate is bought at 20 years' purchase; what rate of interest does the purchaser receive?

34. A freehold estate is sold at 15 years' purchase; what interest does the purchaser receive?

35. A freehold estate is sold at 18⅓ years' purchase; what rate of interest is allowed to the purchaser?

36. A freehold estate is sold at 12⅔ years' purchase; what rate of interest does the purchaser obtain?

Prob. X. To find at how many years' purchase a freehold estate is bought, the rate of interest which the purchaser receives being given.

Rule. Divide *unity* by the interest of £1 for a year.

Ex.—At how many years' purchase should an estate be bought that the buyer may receive 3½ per cent.?

Here, $1 \div {\cdot}035 = 28\frac{4}{7}$ years.

37. At how many years' purchase must an estate be bought that the purchaser may receive 5 per cent.?

38. At how many years' purchase must a freehold estate be bought that the purchaser may receive 4½ per cent.?

39. In what time will a freehold estate clear itself, if the purchaser receives 3¾ per cent. interest?

40. The purchaser of a freehold estate wishes to obtain 8½ per cent.; in what time should the estate clear itself?

Prob. XI. To find the present worth, the yearly rent of a perpetuity, *in reversion*, and the rate of interest, being given.

Rule. Find the present worth of the reversion by Prob. IV.; then find the present worth of this result, for the time which must elapse before the commencement of the annuity.

Ex.—What is the present value of a perpetuity of £200 a-year, to commence 8 years hence, int. at 4 per cent.?

Here, val. of a perpetuity of £1 per an. at 4 p. c. = £25, and pr. va. of £1 for 8 ye. at 4 p. c. by Table II. = £·730690; then £·730690 × 25 × 200 = £3653·45, pres. val.

41. What is the present worth of the reversion of a freehold estate, to continue for ever, but not to be entered upon till the expiry of 6 years, the annual rent being £250, and interest 5 per cent. per annum?

42. What is the present worth of a perpetuity of £500 a-year, to commence 5 years hence, int. at 4 per cent.?

43. The reversion of a freehold estate of £350 a-year, to commence 8 years hence, and to continue for ever, is to be sold; how much should it bring, int. at 4 per cent.?

44. What is the present worth of a freehold estate of £1200 a-year, to be entered upon 10 years hence, and to continue for ever, interest at 4½ per cent.?

Prob. XII. To find the annual rent, the present worth of a perpetuity, *in reversion*, and the rate of interest, being given.

Rule. Find the amount of the present worth for the time before the reversion commences; then, by Prob. V., find the yearly rent which that amount will purchase.

Ex.—The reversion of a perpetuity to commence 8 years hence is sold for £3653·45; what is the annuity, int. at 4 per cent.? Ans. £200, annuity.

Here, by Table I., £1 for 8 ye. at 4 p. c. amounts to £1·36857; then, £1·36857 × ·04 × 3653·45 = £200, annuity.

45. The reversion of a freehold estate, to be entered upon 6 years hence, is sold for £1240, 10s.; what is the yearly rent, allowing the purchaser 4 per cent.?

46. The reversion of a perpetuity, to commence 10 years hence, is sold for £8000; what is the annuity, interest at 5 per cent. per annum?

47. The reversion of a freehold estate, which commences 8 years hence, is sold for £6150; what is the yearly rent, interest at 4½ per cent. per annum?

48. The reversion of a freehold estate, which commences 4 years hence, is sold for £100000; what should the annual rent be, that the purchaser may obtain 5 p. c. per an.?

CONTINGENT OR LIFE ANNUITIES

ARE periodical incomes, yearly or otherwise, which commence or terminate upon the failure or extinction of one or more lives; the value of such annuities, therefore, depends on the probability of the duration of human life, and on the rate of interest.

The calculations of Life Annuities are based on Tables of Mortality which show how many persons on an average, out of a certain number born, are left at the end of each year to the extremity of life. Tables of mortality have been formed from registers kept at Breslau, Northampton, Carlisle, etc.; those used in the following pages are the Northampton Tables.

NOTE. The probability of an event happening is measured by a fraction, the numerator of which is the number of ways in which it can happen, and the denominator of which is the number of ways in which it can happen or fail.

PROBLEM I. To find the expectation of any single life.

RULE. Divide the sum of all the living in Table V., from the age of the life to 96 inclusive, by the number of the living at the age, and from the quotient subtract ·5.

EX.—How many years may a person aged 60 expect to live? ANS. 13·21 years.

Here, the sum of all the living from 60 to 96, in Table V., is 27953; then, $(27953 \div 2038) - \cdot 5 = 13\cdot 21$ years.

1. How many years may a person aged 50 expect to live?
2. How many years may a person aged 31 expect to live?
3. What are the separate expectations of life, of four persons, aged 25, 35, 45, and 75, respectively?

4. What are the separate expectations of life, of four persons, aged 10, 20, 30, and 40 years, respectively?

Prob. II. To find the probability that a life shall continue any number of years, or attain to a proposed age.

Rule. Make the number of living opposite the proposed age in Table V., the numerator of a fraction, and the number opposite the age of the life the denominator.

Ex.—What is the probability that a person aged 30 shall live 30 years or attain the age of 60 years? Ans. $\frac{1}{2}$ nearly.

Here, by Table V., number of living at 30 is 4385, and at 60, 2038; hence, $\frac{2038}{4385} = \frac{1}{2}$ nearly is the probability.

Note. The product of the fractions found in this way shows the probability that two or more joint lives shall attain a proposed age.

5. What is the probability that a person 40 years of age shall live 20 years, or attain the age of 60?

6. What is the probability that two persons, whose ages are 25 and 30 years, shall jointly live 10 years?

7. What is the probability that three persons, whose ages are 25, 35, and 40 years, shall jointly attain the age of 60?

8. What is the probability that four persons, whose ages are 20, 30, 40, and 50, shall jointly live 5 years, and also that they shall jointly attain the age of 60?

Prob. III. To find the probability that one of two persons of different ages shall live a certain number of years.

Rule. Find the probability that *each* of the persons shall live the proposed number of years, and also the probability that they shall *jointly* live that number of years, then subtract the last from the sum of the other two.

Ex.—What is the probability that one of two persons, aged 25 and 35, shall live 30 years? Ans. $\frac{849354}{1192975}$.

$$\text{Here, } \tfrac{2448}{4760} + \tfrac{1632}{4010} - \left(\tfrac{2448}{4760} \times \tfrac{1632}{4010}\right) = \frac{613530 + 485520 - 249696}{1192975} = \frac{849354}{1192975}, \text{ probability.}$$

9. What is the probability that one of two persons, aged 30 and 45, shall live 25 years?

10. What is the probability that one of two persons, aged 20 and 30 years, shall live 30 years?

11. What is the probability that one of two persons, whose ages are 30 and 50, shall live 10 years?

12. What is the probability that one of two persons, whose ages are 15 and 20, shall attain the age of 40?

Prob. IV. To find the value of an annuity on a *single* life.

Rule. Multiply the number opposite the life in Table VII., by the proposed annuity.

Ex.—Find the value of an annuity of £60 a-year during the life of a person aged 40 years at 5 per cent.

Here, by Table VII., £11·837 × 60 = £710·22, value.

13. What is the value of an annuity of £80 a-year during the life of a person aged 35 years, interest at 4 per cent.?

14. How much must be paid by a person aged 50 years, for an annuity of £100 a-year, during the continuance of his life, interest at 5 per cent.?

15. What is the value of the life interest of a person aged 40 years, in £4500 stock in the 4 per cents., interest at 5 per cent.?

16. A person in trade marries a lady, aged 22 years, whose fortune is £250 per annum for life, and being desirous of extending his business he wishes to convert his wife's fortune into money; how much should he receive, reckoning interest at 5 per cent.?

17. What is the difference between the value of an annuity of £40 a-year, certain for 20 years, and the same annuity during the life of a person aged 35 years, interest at 5 per cent.?

18. What is the difference in value between an annuity of £100 a-year, certain for 30 years, and an annuity of the same amount yearly, during the life of a person aged 25 years, interest at 4 per cent.?

Prob. V. To find what annuity any sum will purchase, during the life of a person of a given age.

Rule. Divide the given sum by the number opposite the given age in Table VII.

Ex.—What annuity may a person aged 40 purchase for £710·22, int. at 5 per cent.? Ans. £60 per annum.

Here, by Table VII., £710·22 ÷ 11·837 = £60 per annum.

19. A person aged 25 years lays out £3000 on an annuity for life; what annuity will this purchase, interest at 5 per cent.?

20. A person aged 35 years expends £5000 on an annuity for life; what annuity will this sum purchase, interest at 4 per cent.?

21. When the 4 per cents. were selling at 92½ per cent., a person aged 50 years, who held £6000 stock, wished to exchange this for an annuity during his life; what yearly sum should he have received, interest at 4 per cent.?

22. A father aged 56, receives an annuity of £150 for life, but he wishes to exchange it for an annuity of the same sum to continue during the life of an only daughter, whose age is 30 years; how much must he pay for the exchange, interest at 5 per cent.?

23. A gentleman aged 60 years has an annuity of £100 a-year during the life of his son, whose age is 30 years, but he is anxious to exchange it for an equivalent annuity during his own life; what should this be, interest at 4 per cent.?

Prob. VI. To find the value of an annuity on a single life, for a term of years.

Rule. Multiply the value of a life as many years older than the given life as are equal to the term for which the annuity is proposed, by the present value of £1 payable at the end of the term, and also by the probability that the life shall continue so long; then subtract the product from the value of the given life.

Ex.—Find the value of an annuity of £40 for 10 years on a life aged 35, at 4 per cent. Ans. £292·79464.

Here, value of £1 per annum on a life of 35, by Tab. VII. = £14·041; value of £1 per annum on a life of 45 = £12·283; present value of £1 for 10 years, by Tab. II. = £·675564, and probability of a life aged 35 living to 45 is $\frac{3248}{4010}$; then, £14·041 − £12·283 × ·675564 × $\frac{3248}{4010}$ = £14·041 − £6·721134 = £7·319866 × 40 = £292·79464, value.

24. What is the value of an annuity of £40 for 10 years, upon a life of 60 years, at 5 per cent.?

25. What is the value of an annuity of £100 for 20 years, on a life of 30 years, at 4 per cent.?

26. What is the value of an annuity of £80 for 12 years, upon a life of 40 years, at 4 per cent.?

27. What is the value of an annuity of £120 for 15 years, on a life of 50 years, at 3 per cent.?

Prob. VII. To find the value of an annuity on the *longer* of *two* lives.

Rule. From the sum of the values of the single lives, Tab. VII., take the value of the joint lives, Tab. VIII.

Ex.—Find the value of an annuity of £60 on the longer of two lives aged 40 and 50, at 4 per cent. Ans. £937·68.

Here, value of £1 per annum on a life of 40 years, Tab. VII. = £13·197, value of £1 per annum on a life of 50 years, = £11·265, and value of £1 per annum on two lives, 40 and 50, by Tab. VIII. = £8·834; then (£13·197 + £11·265 — £8·834) × 60 = £15·628 × 60 = £937·680, value.

28. What is the value of an annuity of £80 on the longer of two lives, aged 10 and 25, at 5 per cent.?

29. What is the value of an annuity of £100 on the longer of two lives, aged 20 and 45, at 4 per cent.?

30. What is the value of an annuity of £60 on the longer of two lives, aged 35 and 40, at 5 per cent.?

31. What is the value of an annuity of £120 on the longer of two lives, aged 30 and 50, at 4 per cent.?

Prob. VIII. To find the value of an annuity on *three joint* lives.

Rule. Find the value of the joint lives of the two elder, Tab. VIII., and find the *age* of a single life equal to that value in Tab. VII.; then find the joint value of the lives of the youngest, and that now found.

Note. This rule is only an approximation to the value.

Ex.—Find the value of an annuity of £90 on *three* joint lives, aged 20, 30, and 40, at 4 per cent.

Here, by Table X., £8·986 × 90 = £808·740, value; or value of joint lives 30 and 40, Table VIII., is £10·490, which is found nearly opposite $53\frac{2}{3}$ years in Table VII.; then value of £1 on joint lives 20 and $53\frac{2}{3}$, Table VIII., is £9·630 — (9·630 — 8·869) × $3\frac{2}{3}$ ÷ 5 = £9·072, and £9·072 × 90 = £816·480, value rather more than is found by Table X.

32. What is the value of an annuity of £500 on three joint lives, aged 20, 35, and 40, at 5 per cent.?
33. What is the value of an annuity of £300 on three joint lives, aged 10, 15, and 55, at 5 per cent.?
34. What is the value of an annuity of £460 on three joint lives, aged 15, 25, and 35, at 5 per cent.?
35. What is the value of an annuity of £360 on three joint lives, aged 20, 35, and 50, at 5 per cent.?

Prob. IX. To find the value of an annuity on the *longest* of *three* lives.

Rule. From the sum of the values of all the single lives, Tab. VII., and of the three joint lives, Tab. X., subtract the sum of the values of each *pair* of joint lives, Tab. VIII.

Ex.—Find the value of an annuity of £300 on the longest of three lives, aged 25, 35, and 45, at 4 per cent.

Here, value of £1 per annum on the three separately and jointly, is £15·440 + £14·041 + £12·283 + £8·313 = £50·077; also value of £1 per annum on the pairs, 25 and 35, 25 and 45, 35 and 45 = £11·217 + £10·160 + £9·706 = £31·083; then (£50·077 — £31·083) × 300 = £18·994 × 300 = £5698·2

36. What is the value of an annuity of £500, on the longest of three lives, aged 20, 30, and 40, at 4 p. c.?
37. What is the value of an annuity of £100, on the longest of three lives, aged 15, 25, and 35, at 4 p. c.?
38. What is the value of an annuity of £150, on the longest of three lives, aged 20, 30, and 60, at 4 p. c.?
39. What is the value of an annuity of £250, on the longest of three lives, aged 25, 35, and 45, at 4 p. c.?

Prob. X. To find the value of an annuity granted upon three lives, on condition of its *ceasing*, as soon as any *two* of them become extinct.

Rule. From the sum of the values of each pair of joint lives Tab. VIII., subtract twice the value of the three jointly Tab. X.

Ex.—Find the value of an annuity of £70 on three lives, aged 15, 25, and 35, to cease on the failure of any two of the lives, at 4 per cent. Ans. £1131·06.

Here, the value of £1 per an. on the pairs, 15 and 25, 15 and 35, 25 and 35, is £12·630 + £11·787 + £11·217 = £35·634; also, value of £1 per an. on the three jointly doubled is £19·476; then (£35·634 — £19·476) × 70 = £16·158 × 70 = £1131·06.

40. An annuity of £150 is granted upon three lives, aged 20, 30, and 40; it is to cease on the failure of any two of the lives: what is its value at 4 per cent.?

41. What is the value of an annuity of £200 upon three lives, aged 10, 20, and 30, to cease as soon as any two of the lives fail, at 4 per cent.?

42. What is the value of an annuity of £300 upon three lives, each 30, to cease when any two of the lives fail, at 4 per cent.?

43. What should be given for an annuity of £90 on three lives, aged 15, 25, and 35, to cease when any two of the lives fail, at 4 per cent.?

Prob. XI. To find the value of an annuity during the remainder of A's life, *after the failure* of B's.

Rule. From the value of A's life subtract that of the joint lives of A and B, for the value in one payment.

Ex.—Find the value of an annuity of £50 during the continuance of a life aged 30, after the failure of a life aged 50, at 4 per cent. Ans. £273·1.

Here, value of £1 per annum on a life of 30 = £14·783, and value of £1 per annum on joint lives 30 and 50 = £9·321; then (£14·783 — £9·321) × 50 = £5·462 × 50 = £273·1 value.

Note. To find the annual payments during the life of B, divide the value in one payment by the value of the joint lives *plus unity*, if the *first* payment is to be made immediately, or by the value of the joint lives if it is to be made at the end of the year.

44. What is the value of an annuity of £50 during the

continuance of the life of a person aged 25, after the death of another aged 40, at 5 per cent.?

45. What is the value of an annuity of £100, to be enjoyed by a person aged 30, after the death of another aged 50, at 5 per cent.?

46. A father aged 40 wishes to secure an annuity of £80 after his death to an only daughter aged 20; how much must he pay for it, at 5 per cent.?

47. A gentleman aged 50 married a wife of 25 years of age, and purchased an annuity of £150, to be enjoyed by her after his death; how much did he pay for it, at 5 p. c.?

Prob. XII. To find the value of an annuity on the life of A *after the failure* of the two lives of B and C.

Rule. From the sum of the values of A's life, and of the *three* joint lives, subtract the sum of the values of the two joint lives of A and B and of A and C.

Ex.—Find the value of an annuity of £80 on a life aged 25, after the failure of two lives aged 35 and 45, at 4 p. c.

Here, value of £1 per an. on a life of 25, *plus* val. of £1 per annum on the three, 25, 35, and 45, jointly, = £15·440 + £8·313 = £23·753, also values of the two lives 25, 35, and 25, 45 = £11·217 + £10·160 = £21·377; then (£23·753 — £21·377) × 80 = £2·376 × 80 = £190·08, value.

48. What is the value of an annuity of £70, to be enjoyed by a person aged 20, after the deaths of two others aged 30 and 40, at 4 per cent.?

49. A gentleman has three sons, whose ages are 15, 25, and 35, and the youngest is to have an annuity of £80 for life, after the deaths of his two brothers; what is its value, at 4 per cent.?

50. A daughter, aged 25, is to have an annuity of £50 for life, after the deaths of her parents, whose ages are 50 and 65; what is its value, at 5 per cent.?

51. A gentleman and his brother, whose ages are 65 and 50, wish to secure an annuity, after their decease, to a person whose age is 15; what is its value, at 5 per cent.?

Prob. XIII. To find the value of a given sum, payable on the *failure* of a given life; or to find how much must be paid annually by a person of a given age, that his heirs may receive a given sum on his decease.

RULE. Subtract the value of the life from that of the *perpetuity*, then divide by the *perpetuity plus one* for the value in a *single* payment. Divide the value in a single payment by that of the life *plus one* for the annual payments.

Ex.—What is the present value of £2000, payable on the decease of a person aged 35, at 4 per cent.?

Here, value of £1 perpetuity is £100 ÷ 4 = £25, and of a life aged 35 is £14·041; then (£25 — £14·041) ÷ 26 = £10·959 ÷ 26 = £·4215, and £·4215 × 2000 = £843, value in a single payment; also, £843 ÷ 15·041 = £56·0468, the annual premium of insurance on a life aged 35, payable at the commencement of each year.

NOTE 1. If the first annual payment is to be made at the end of the year, divide only by the value of the given life.

NOTE 2. If the value of the reversion of an estate were required instead of a sum of money after the failure of the life, the value of the life must be deducted from the perpetuity.

NOTE 3. The value of a given sum, payable on the extinction of any two or three joint lives, or of the longest of these lives, is found by substituting the values of the *joint* lives, or the *longest* of the lives instead of the value of the single life.

52. What is the present value of £2500, payable on the decease of a person aged 45, at 4 per cent.; and what should be the annual payments?

53. What ought a person aged 50 to pay annually to insure £1500 to his children at his death; and what is the value of the same in one payment, at 3 per cent.?

54. What is the value of £2000, payable on the failure of two joint lives, aged 30 and 45, interest at 5 per cent.?

55. What is the value of £1000, payable on the failure of the longer of two lives, aged 25 and 30, at 5 per cent.?

56. What is the value of £500, payable on the failure of three joint lives, aged 10, 20, and 30, at 4 per cent.?

57. What is the value of £1500, payable on the extinction of the longest of three lives, aged 15, 25, and 35, at 4 per cent.?

58. What is the value of a freehold estate of £500 yearly rent, to be entered upon at the decease of a person aged 30, at 4 per cent.?

59. What is the value of a freehold estate of £1500 yearly rent, to be entered upon at the failure of two joint lives, aged 35 and 50, at 4 per cent.?

60. What is the value of the same estate, to be entered upon at the extinction of the longer of two lives, aged 35 and 45, at 4 per cent.?

61. What is the value of an estate of £2000 yearly rent, to be entered upon at the failure of three joint lives, aged 10, 20, and 30, at 4 per cent.?

62. What is the value of the same estate, to be entered upon at the extinction of the longest of these three lives, at 4 per cent.?

63. What is the value in annual payments of £3000, to be received at the death of the longer of two lives, aged 35 and 40, at 4 per cent.?

PROMISCUOUS EXERCISES.

1. What should a man, whose age is 25, and that of his wife 20, pay for an annuity of £150 for his widow, at 5 p. c.?

2. A man aged 40, whose wife is 30, wishes to secure her an annuity of £80 after his death, provided she survives him; how much should he pay presently, or in annual payments, at 4 per cent.?

3. A husband's age is 45, and that of his wife 40; how much should he pay, either annually or at one payment, to secure an annuity of £120 a-year for her after his death, provided she survives him, interest at 4 per cent.?

4. A husband aged 30 wishes to secure an annuity of £100 to his wife, whose age is 25, should she survive him; how much should he pay, either annually or in one payment, at 5 per cent.?

5. What ought a man of 45 to pay presently, or in annual payments, during his life, to assure £1000 to his heirs at his death, at 5 per cent.?

6. What ought a man of 40 to pay, in order to assure £100 to his heirs at his death, at 4 per cent.?

7. What should a man, whose age is 50, pay for an an-

nuity of £30, to continue during the joint lives of himself and of his wife, whose age is 40, at 4 per cent.?

8. What should a person, aged 40, pay annually to secure £3000 to his children at his death, interest at 5 per cent.?

9. What is the value at 4 per cent. of an annuity of £150 during the joint continuance of three lives, aged 25, 30, and 35 years?

10. What should a father pay, at 4 per cent., to purchase an annuity of £200, to continue till he himself aged 50, and his two sons aged 30 and 25 years respectively, are all extinct?

11. What is the value of a freehold estate of £450 a-year, to be entered upon at the decease of a person aged 54 years, interest at 4 per cent.?

12. What should a man, whose age is 45, and that of his wife 40, pay for an annuity of £20, to continue until the death of the longer liver, at 5 per cent.?

13. What should a man, whose age is 35, and that of his wife 30, pay presently, or annually, to purchase an annuity for his widow if he die first, at 4 per cent.?

14. What should a man of 35 pay annually during his life, to secure an annuity of £40 for his wife, whose age is 25, if she survive him, at 5 per cent.?

15. A society of married men pay each £12 at entry, besides an annual contribution during their lives, which is regulated by their ages at entering; what should a man of 35 pay annually to secure an annuity of £30 for his wife after his death, if she outlive him, at 4 per cent.?

16. Suppose the conditions to be the same as in the last, but that the husband must have contributed 5 years, otherwise the widow receives no annuity; how much should he contribute annually?

17. Suppose the members who enter at 35, to pay £5 annually, provided their wives be of the same age, but they pay a fine at entry, when their wives are younger; what should a man pay whose wife's age is 25?

18. Suppose members be admitted above the age of 35, upon paying a fine as a compensation for age; what should this fine be for a man whose age is 45, the other conditions being as before?

TABLES OF COMPOUND INTEREST AND ANNUITIES.

Table I.

Showing the Amount of £1, at Compound Interest, in any number of Years not exceeding 60, at the rates of 3, 4, and 5 per cent. per annum.

Years.	Three per cent.	Four per cent.	Five per cent.	Years.	Three per cent.	Four per cent.	Five per cent.
1	1·03000	1·04000	1·05000	31	2·50008	3·37313	4·53804
2	1·06090	1·08160	1·10250	32	2·57508	3·50806	4·76494
3	1·09273	1·12486	1·15763	33	2·65234	3·64838	5·00319
4	1·12551	1·16986	1·21551	34	2·73191	3·79432	5·25335
5	1·15927	1·21665	1·27628	35	2·81386	3·94609	5·51602
6	1·19405	1·26532	1·34010	36	2·89828	4·10393	5·79182
7	1·22987	1·31593	1·40710	37	2·98523	4·26809	6·08141
8	1·26677	1·36857	1·47746	38	3·07478	4·43881	6·38548
9	1·30477	1·42331	1·55133	39	3·16703	4·61637	6·70475
10	1·34392	1·48024	1·62889	40	3·26204	4·80102	7·03999
11	1·38423	1·53945	1·71034	41	3·35990	4·99306	7·39199
12	1·42576	1·60103	1·79586	42	3·46070	5·19278	7·76159
13	1·46853	1·66507	1·88565	43	3·56452	5·40050	8·14967
14	1·51259	1·73168	1·97993	44	3·67145	5·61652	8·55715
15	1·55797	1·80094	2·07893	45	3·78160	5·84118	8·98501
16	1·60471	1·87298	2·18287	46	3·89504	6·07482	9·43426
17	1·65285	1·94790	2·29202	47	4·01190	6·31782	9·90597
18	1·70243	2·02582	2·40662	48	4·13225	6·57053	10·40127
19	1·75351	2·10685	2·52695	49	4·25622	6·83335	10·92133
20	1·80611	2·19112	2·65330	50	4·38391	7·10668	11·46740
21	1·86029	2·27877	2·78596	51	4·51542	7·39095	12·04077
22	1·91610	2·36992	2·92526	52	4·65089	7·68659	12·64281
23	1·97359	2·46472	3·07152	53	4·79041	7·99405	13·27495
24	2·03279	2·56330	3·22510	54	4·93412	8·31381	13·93870
25	2·09378	2·66584	3·38635	55	5·08215	8·64637	14·63563
26	2·15659	2·77247	3·55567	56	5·23461	8·99222	15·36741
27	2·22129	2·88337	3·73346	57	5·39165	9·35191	16·13578
28	2·28793	2·99870	3·92013	58	5·55340	9·72599	16·94257
29	2·35657	3·11865	4·11614	59	5·72000	10·11503	17·78970
30	2·42726	3·24340	4·32194	60	5·89160	10·51963	18·67919

Note. To find the amount of any sum of money; take the number from the Table answering to the given rate and time, and multiply it by the given sum.

Table II.

Showing the Present Value of £1 to be received at the end of any number of Years not exceeding 60, discounting at the rates of 3, 4, and 5 per cent. Compound Interest.

Years.	Three per cent.	Four per cent.	Five per cent	Years.	Three per cent.	Four per cent.	Five per cent.
1	·970874	·961538	·952381	31	·399987	·296460	·220359
2	·942596	·924556	·907029	32	·388337	·285058	·209866
3	·915142	·888996	·863838	33	·377026	·274094	·199873
4	·888487	·854804	·822702	34	·366045	·263552	·190355
5	·862609	·821927	·783526	35	·355383	·253415	·181290
6	·837484	·790315	·746215	36	·345032	·243669	·172657
7	·813092	·759918	·710681	37	·334983	·234297	·164436
8	·789409	·730690	·676839	38	·325226	·225285	·156605
9	·766417	·702587	·644609	39	·315754	·216621	·149148
10	·744094	·675564	·613913	40	·306557	·208289	·142046
11	·722421	·649581	·584679	41	·297628	·200278	·135282
12	·701380	·624597	·556837	42	·288959	·192575	·128840
13	·680951	·600574	·530321	43	·280543	·185168	·122704
14	·661118	·577475	·505068	44	·272372	·178046	·116861
15	·641862	·555265	·481017	45	·264439	·171198	·111297
16	·623167	·533908	·458112	46	·256737	·164614	·105997
17	·605016	·513373	·436297	47	·249259	·158283	·100949
18	·587395	·493628	·415521	48	·241999	·152195	·096142
19	·570286	·474642	·395734	49	·234950	·146341	·091564
20	·553676	·456387	·376889	50	·228107	·140713	·087204
21	·537549	·438834	·358942	51	·221463	·135301	·083051
22	·521893	·421955	·341850	52	·215013	·130097	·079096
23	·506692	·405726	·325571	53	·208750	·125093	·075330
24	·491934	·390121	·310068	54	·202670	·120282	·071743
25	·477606	·375117	·295303	55	·196767	·115656	·068326
26	·463695	·360689	·281241	56	·191036	·111207	·065073
27	·450189	·346817	·267848	57	·185472	·106930	·061974
28	·437077	·333477	·255094	58	·180070	·102817	·059023
29	·424346	·320651	·242946	59	·174825	·098863	·056212
30	·411987	·308319	·231377	60	·169733	·095060	·053536

Note. To find the present value of any sum of money; take the number from the Table answering to the given rate and time, and multiply it by the given sum.

TABLE III.

Showing the Amount of £1 Annuity, for any number of Years not exceeding 60, at the rates of 3, 4, and 5 per cent. Compound Interest.

Years.	Three per cent.	Four per cent.	Five per cent.	Years.	Three per cent.	Four per cent.	Five per cent.
1	1·0000	1·0000	1·0000	31	50·0027	59·3283	70·7608
2	2·0300	2·0400	2·0500	32	52·5028	62·7015	75·2988
3	3·0909	3·1216	3·1525	33	55·0778	66·2095	80·0638
4	4·1836	4·2465	4·3101	34	57·7302	69·8579	85·0670
5	5·3091	5·4163	5·5256	35	60·4621	73·6522	90·3203
6	6·4684	6·6330	6·8019	36	63·2759	77·5983	95·8363
7	7·6625	7·8983	8·1420	37	66·1742	81·7022	101·6281
8	8·8923	9·2142	9·5491	38	69·1594	85·9703	107·7095
9	10·1591	10·5828	11·0266	39	72·2342	90·4091	114·0950
10	11·4639	12·0061	12·5779	40	75·4013	95·0255	120·7998
11	12·8078	13·4864	14·2068	41	78·6633	99·8265	127·8398
12	14·1920	15·0258	15·9171	42	82·0232	104·8196	135·2318
13	15·6178	16·6268	17·7130	43	85·4839	110·0124	142·9933
14	17·0863	18·2919	19·5986	44	89·0484	115·4129	151·1430
15	18·5989	20·0236	21·5786	45	92·7199	121·0294	159·7002
16	20·1569	21·8245	23·6575	46	96·5015	126·8706	168·6852
17	21·7616	23·6975	25·8404	47	100·3965	132·9454	178·1194
18	23·4144	25·6454	28·1324	48	104·4084	139·2632	188·0254
19	25·1169	27·6712	30·5390	49	108·5406	145·8337	198·4267
20	26·8704	29·7781	33·0660	50	112·7969	152·6671	209·3480
21	28·6765	31·9692	35·7193	51	117·1808	159·7738	220·8154
22	30·5368	34·2480	38·5052	52	121·6962	167·1647	232·8562
23	32·4529	36·6179	41·4305	53	126·3471	174·8513	245·4990
24	34·4265	39·0826	44·5020	54	131·1375	182·8454	258·7739
25	36·4593	41·6459	47·7271	55	136·0716	191·1592	272·7126
26	38·5530	44·3117	51·1135	56	141·1538	199·8055	287·3482
27	40·7096	47·0842	54·6691	57	146·3884	208·7978	302·7157
28	42·9309	49·9676	58·4026	58	151·7800	218·1497	318·8514
29	45·2189	52·9663	62·3227	59	157·3334	227·8757	335·7940
30	47·5754	56·0849	66·4388	60	163·0534	237·9907	353·5837

NOTE. To find the amount of any annuity; take the number from the Table answering to the given rate and time, and multiply it by the given annuity

TABLE IV.

Showing the Present Value of £1 Annuity, for any number of Years not exceeding 60, at the rates of 3, 4, and 5 per cent. Compound Interest.

Years.	Three per cent.	Four per cent.	Five. per cent.	Years.	Three per cent.	Four per cent.	Five per cent.
1	0·9709	0·9615	0·9524	31	20·0004	17·5885	15·5928
2	1·9135	1·8861	1·8594	32	20·3888	17·8736	15·8027
3	2·8286	2·7751	2·7232	33	20·7658	18·1476	16·0025
4	3·7171	3·6299	3·5460	34	21·1318	18·4112	16·1929
5	4·5797	4·4518	4·3295	35	21·4872	18·6646	16·3742
6	5·4172	5·2421	5·0757	36	21·8323	18·9083	16·5469
7	6·2303	6·0021	5·7864	37	22·1672	19·1426	16·7113
8	7·0197	6·7327	6·4632	38	22·4925	19·3679	16·8679
9	7·7861	7·4353	7·1078	39	22·8082	19·5845	17·0170
10	8·5302	8·1109	7·7217	40	23·1148	19·7928	17·1591
11	9·2526	8·7605	8·3064	41	23·4124	19·9931	17·2944
12	9·9540	9·3851	8·8633	42	23·7014	20·1856	17·4232
13	10·6350	9·9856	9·3936	43	23·9819	20·3708	17·5459
14	11·2961	10·5631	9·8986	44	24·2543	20·5488	17·6628
15	11·9379	11·1184	10·3797	45	24·5187	20·7200	17·7741
16	12·5611	11·6523	10·8378	46	24·7755	20·8847	17·8801
17	13·1661	12·1657	11·2741	47	25·0247	21·0429	17·9810
18	13·7535	12·6593	11·6896	48	25·2667	21·1951	18·0772
19	14·3238	13·1339	12·0853	49	25·5017	21·3415	18·1687
20	14·8775	13·5903	12·4622	50	25·7298	21·4822	18·2559
21	15·4150	14·0292	12·8212	51	25·9512	21·6175	18·3390
22	15·9369	14·4511	13·1630	52	26·1662	21·7476	18·4181
23	16·4436	14·8568	13·4886	53	26·3750	21·8727	18·4934
24	16·9355	15·2470	13·7986	54	26·5777	21·9930	18·5651
25	17·4131	15·6221	14·0939	55	26·7744	22·1086	18·6335
26	17·8768	15·9828	14·3752	56	26·9655	22·2198	18·6985
27	18·3270	16·3296	14·6430	57	27·1509	22·3267	18·7605
28	18·7641	16·6631	14·8981	58	27·3310	22·4296	18·8195
29	19·1885	16·9837	15·1411	59	27·5058	22·5284	18·8757
30	19·6004	17·2920	15·3724	60	27·6756	22·6235	18·9293

NOTE. To find the present value of any annuity; take the number from the Table answering to the given rate and time, and multiply it by the given annuity.

TABLE V.

Showing the Annual Decrements of Life or Law of Mortality according to the observations made at Northampton.

Age.	Living.	Dying.	Age.	Living.	Dying.	Age.	Living.	Dying.	Age.	Living.	Dying.
0	11650	3000	25	4760	75	50	2857	81	75	832	80
1	8650	1367	26	4685	75	51	2776	82	76	752	77
2	7283	502	27	4610	75	52	2694	82	77	675	73
3	6781	335	28	4535	75	53	2612	82	78	602	68
4	6446	197	29	4460	75	54	2530	82	79	534	65
5	6249	184	30	4385	75	55	2448	82	80	469	63
6	6065	140	31	4310	75	56	2366	82	81	406	60
7	5925	110	32	4235	75	57	2284	82	82	346	57
8	5815	80	33	4160	75	58	2202	82	83	289	55
9	5735	60	34	4085	75	59	2120	82	84	234	48
10	5675	52	35	4010	75	60	2038	82	85	186	41
11	5623	50	36	3935	75	61	1956	82	86	145	34
12	5573	50	37	3860	75	62	1874	81	87	111	28
13	5523	50	38	3785	75	63	1793	81	88	83	21
14	5473	50	39	3710	75	64	1712	80	89	62	16
15	5423	50	40	3635	76	65	1632	80	90	46	12
16	5373	53	41	3559	77	66	1552	80	91	34	10
17	5320	58	42	3482	78	67	1472	80	92	24	8
18	5262	63	43	3404	78	68	1392	80	93	16	7
19	5199	67	44	3326	78	69	1312	80	94	9	5
20	5132	72	45	3248	78	70	1232	80	95	4	3
21	5060	75	46	3170	78	71	1152	80	96	1	1
22	4985	75	47	3092	78	72	1072	80	...	...	...
23	4910	75	48	3014	78	73	992	80	...	...	...
24	4835	75	49	2936	79	74	912	80	...	...	...

NOTE 1. Of 11650 children born, 3000 will die before they reach the age of 1 year; and of the 8650, who live to be 1 year old, 1367 will die before they reach the age of 2 years, and so on.

NOTE 2. Although the Carlisle Tables are chiefly used in this country and the United States, the Northampton Tables have still been retained in this work, as the method of calculating questions in Life Annuities is the same for any Tables of Mortality.

TABLE VI.

Showing the Expectation of Life at every age, as deduced from the preceding Table of observations.

Age.	Expect.	Age.	Expect.	Age.	Expect.	Age.	Expect.
0	25·18	25	30·85	50	17·99	75	6·54
1	32·74	26	30·33	51	17·50	76	6·18
2	37·79	27	29·82	52	17·02	77	5·83
3	39·55	28	29·30	53	16·54	78	5·48
4	40·58	29	28·79	54	16·06	79	5·11
5	40·84	30	28·27	55	15·58	80	4·75
6	41·07	31	27·76	56	15·10	81	4·41
7	41·03	32	27·24	57	14·63	82	4·09
8	40·79	33	26·72	58	14·15	83	3·80
9	40·36	34	26·20	59	13·68	84	3·58
10	39·78	35	25·68	60	13·21	85	3·37
11	39·14	36	25·16	61	12·75	86	3·19
12	38·49	37	24·64	62	12·28	87	3·01
13	37·83	38	24·12	63	11·81	88	2·86
14	37·17	39	23·60	64	11·35	89	2·66
15	36·51	40	23·08	65	10·88	90	2·41
16	35·85	41	22·56	66	10·42	91	2·09
17	35·20	42	22·04	67	9·96	92	1·75
18	34·58	43	21·54	68	9·50	93	1·37
19	33·99	44	21·03	69	9·05	94	1·05
20	33·43	45	20·52	70	8·60	95	0·75
21	32·90	46	20·02	71	8·17	96	0·50
22	32·39	47	19·51	72	7·74	...	...
23	31·88	48	19·00	73	7·33	...	...
24	31·36	49	18·49	74	6·92	...	...

NOTE. By the *expectation of life* is meant, that out of a given number of persons living, of a certain age, one with another may expect to live a *certain number of years*, as some of them will enjoy a duration as much *longer* as others will fall *short* of that period. A person of 40 years of age may live 23·08 years, and of 50 years of age, 17·99 years. It may be observed, that *females* generally live longer than *males*, and *married* women live longer than *single* women.

TABLE VII.

Showing the Value of an Annuity of £1 on a *Single* Life (or number of Years' purchase of an Annuity), according to the probabilities of life at Northampton, at the rates of 3, 4, and 5 per cent.

Age.	Three per cent.	Four per cent.	Five per cent.	Age.	Three per cent.	Four per cent.	Five per cent.
1	16·021	13·466	11·563	36	15·729	13·881	12·377
2	18·599	15·634	13·420	37	15·515	13·717	12·249
3	19·576	16·463	14·135	38	15·298	13·549	12·116
4	20·211	17·011	14·613	39	15·075	13·375	11·979
5	20·473	17·250	14·827	40	14·848	13·197	11·837
6	20·727	17·483	15·041	41	14·620	13·018	11·695
7	20·854	17·612	15·166	42	14·391	12·838	11·551
8	20·886	17·663	15·226	43	14·163	12·658	11·407
9	20·812	17·626	15·210	44	13·930	12·469	11·258
10	20·663	17·525	15·139	45	13·692	12·283	11·105
11	20·480	17·394	15·043	46	13·450	12·089	10·947
12	20·284	17·252	14·937	47	13·203	11·890	10·784
13	20·081	17·105	14·826	48	12·951	11·687	10·616
14	19·873	16·952	14·710	49	12·694	11·476	10·443
15	19·658	16·792	14·588	50	12·436	11·265	10·269
16	19·436	16·626	14·460	51	12·183	11·059	10·097
17	19·218	16·464	14·334	52	11·930	10·850	9·925
18	19·013	16·311	14·217	53	11·674	10·638	9·748
19	18·821	16·169	14·108	54	11·414	10·422	9·567
20	18·638	16·035	14·007	55	11·150	10·201	9·382
21	18·471	15·914	13·917	56	10·883	9·978	9·193
22	18·311	15·800	13·833	57	10·611	9·749	8·999
23	18·149	15·683	13·746	58	10·337	9·517	8·801
24	17·983	15·563	13·658	59	10·059	9·280	8·599
25	17·814	15·440	13·567	60	9·777	9·040	8·392
26	17·642	15·315	13·473	61	9·493	8·796	8·181
27	17·467	15·187	13·377	62	9·205	8·548	7·966
28	17·289	15·056	13·278	63	8·910	8·291	7·742
29	17·107	14·921	13·177	64	8·611	8·031	7·514
30	16·922	14·783	13·072	65	8·305	7·762	7·276
31	16·733	14·642	12·965	66	7·995	7·488	7·034
32	16·540	14·498	12·854	67	7·682	7·211	6·787
33	16·343	14·349	12·740	68	7·367	6·930	6·536
34	16·142	14·195	12·623	69	7·051	6·647	6·281
35	15·938	14·041	12·502	70	6·734	6·362	6·023

TABLE VII.—*Continued.*

Age.	Three per cent.	Four per cent.	Five per cent.	Age.	Three per cent.	Four per cent.	Five per cent.
71	6·418	6·076	5·764	84	2·794	2·708	2·627
72	6·104	5·790	5·504	85	2·620	2·544	2·471
73	5·794	5·508	5·245	86	2·462	2·393	2·328
74	5·491	5·230	4·990	87	2·312	2·252	2·193
75	5·200	4·963	4·744	88	2·185	2·132	2·080
76	4·925	4·710	4·511	89	2·013	1·968	1·924
77	4·652	4·457	4·277	90	1·795	1·758	1·723
78	4·372	4·198	4·035	91	1·501	1·474	1·447
79	4·077	3·922	3·776	92	1·190	1·171	1·153
80	3·781	3·644	3·515	93	0·839	0·828	0·816
81	3·499	3·378	3·263	94	0·536	0·530	0·524
82	3·229	3·122	3·020	95	0·243	0·240	0·238
83	2·982	2·887	2·797	96	...	...	...

TABLE VIII.

Showing the Value of £1 Annuity on the *Joint Continuance* of Two Lives, by the Northampton Tables, at the rates of 4 and 5 per cent.

Ages.	Four per cent.	[illegible]	Ages.	Four per cent.	Five per cent.	Ages.	Four per cent.	Five per cent.
5– 5	[illegible]	[illegible]	10	14·277	12·665	15–15	13·411	11·960
10	[illegible]	[illegible]	15	13·841	12·302	20	12·961	11·585
15	[illegible]	[illegible]	20	13·355	11·906	25	12·630	11·324
[illegible]	[illegible]	[illegible]	25	12·998	11·627	30	12·246	11·021
[illegible]	[illegible]	[illegible]	30	12·586	11·304	35	11·787	10·655
[illegible]	[illegible]	[illegible]	35	12·098	10·916	40	11·234	10·205
[illegible]	[illegible]	[illegible]	40	11·513	10·442	45	10·607	9·690
[illegible]	[illegible]	[illegible]	45	10·851	9·900	50	9·872	9·076
[illegible]	[illegible]	[illegible]	50	10·085	9·260	55	9·077	8·403
[illegible]	[illegible]	[illegible]	55	9·256	8·560	60	8·170	7·622
[illegible]	[illegible]	[illegible]	60	8·314	7·750	65	7·127	6·705
[illegible]	[illegible]	[illegible]	65	7·236	6·803	70	5·933	5·631
[illegible]	[illegible]	[illegible]	70	6·008	5·700	75	4·695	4·495
[illegible]	[illegible]	[illegible]	75	4·725	4·522	80	3·492	3·372
[illegible]	[illegible]	[illegible]	80	3·517	3·395	85	2·462	2·393

Table VIII.—*Continued.*

Ages.	Four p. c.	Five p. c.	Ages.	Four p. c.	Five p. c.	Ages.	Four p. c.	Five p. c.
20–20	12·535	11·232	30–80	3·406	3·290	50–50	8·081	7·522
25	12·229	10·989	85	2·411	2·344	55	7·593	7·098
30	11·873	10·707	90	1·694	1·660	60	6·989	6·568
35	11·445	10·363	95	0·236	0·234	65	6·236	5·897
40	10·924	9·937	35–35	10·612	9·680	70	5·306	5·054
45	10·330	9·448	40	10·196	9·331	75	4·285	4·112
50	9·630	8·861	45	9·706	8·921	80	3·247	3·140
55	8·869	8·216	50	9·110	8·415	85	2·322	2·258
60	7·995	7·463	55	8·448	7·849	90	1·651	1·619
65	6·986	6·576	60	7·669	7·174	95	0·233	0·231
70	5·826	5·532	65	6·747	6·360	55–55	7·179	6·735
75	4·619	4·424	70	5·663	5·382	60	6·659	6·272
80	3·443	3·325	75	4·516	4·327	65	5·986	5·671
85	2·431	2·364	80	3·383	3·268	70	5·132	4·893
90	1·704	1·670	85	2·398	2·331	75	4·171	4·006
25–25	11·944	10·764	90	1·688	1·654	80	3·180	3·076
30	11·618	10·499	95	0·235	0·233	85	2·284	2·222
35	11·217	10·175	40–40	9·820	9·016	90	1·633	1·601
40	10·725	9·771	45	9·381	8·643	95	0·232	0·230
45	10·160	9·304	50	8·834	8·177	60–60	6·226	5·888
50	9·488	8·739	55	8·221	7·651	65	5·658	5·372
55	8·754	8·116	60	7·490	7·015	70	4·900	4·680
60	7·906	7·383	65	6·614	6·240	75	4·021	3·866
65	6·920	6·515	70	5·571	5·298	80	3·092	2·992
70	5·780	5·489	75	4·457	4·272	85	2·234	2·174
75	4·589	4·396	80	3·349	3·236	90	1·608	1·577
80	3·425	3·308	85	2·379	2·313	95	0·230	0·228
85	2·421	2·354	90	1·679	1·646	65–65	5·201	4·960
90	1·699	1·665	95	0·235	0·233	70	4·573	4·378
95	0·236	0·234	45–45	8·990	8·312	75	3·806	3·665
30–30	11·313	10·255	50	8·503	7·891	80	2·965	2·873
35	10·948	9·954	55	7·948	7·411	85	2·163	2·107
40	10·490	9·576	60	7·274	6·822	90	1·575	1·544
45	9·959	9·135	65	6·453	6·094	95	0·228	0·226
50	9·321	8·596	70	5·460	5·195	70–70	4·087	3·930
55	8·619	7·999	75	4·386	4·206	75	3·471	3·347
60	7·802	7·292	80	3·308	3·197	80	2·757	2·675
65	6·844	6·447	85	2·356	2·291	85	2·042	1·991
70	5·729	5·442	90	1·668	1·635	90	1·515	1·486
75	4·557	4·365	95	0·234	0·232	95	0·224	0·222

TABLE VIII.—*Continued.*

Ages.	Four p. c.	Five p. c.	Ages.	Four p. c.	Five p. c.	Ages.	Four p. c.	Five p. c.
75–75	3·015	2·917	85–95	0·187	0·185	34–44	9·869	9·058
80	2·448	2·381	90–90	0·922	0·909	36–46	9·540	8 781
85	1·856	1·811	95	0·177	0·175	38–48	9·195	8·487
90	1·413	1·378	95–95	0·060	0·059	42–52	8·483	7·875
95	0·217	0·215	16–26	12·470	11·193	44–54	8·130	7·569
80–80	2·068	2·018	18–28	12·158	10·939	46–56	7·763	7·249
85	1·608	1·573	22–32	11·615	10·498	48–58	7·382	6·915
90	1·278	1·255	24–34	11·352	10·285	52–62	6·600	6·222
95	0·208	0·206	26–36	11·078	10·062	54–64	6·196	5·860
85–85	1·339	1·256	28–38	10·791	9·826	56–66	5·774	5·479
90	1·054	1·038	32–42	10·182	9·320	12–32	12·286	11·062

TABLE IX.

Showing the Value of £1 Annuity on *Three Equal* Joint Lives, at 4 per cent., by the Northampton Tables.

Age.	Value.	Age.	Value.	Age.	Value.	Age.	Value.
1	5·309	25	9·796	49	6·482	73	2·448
2	8·251	26	9·685	50	6·317	74	2·277
3	9·632	27	9·572	51	6·161	75	2·119
4	10·661	28	9·457	52	6·011	76	1·985
5	11·170	29	9·340	53	5·859	77	1·855
6	11·707	30	9·221	54	5·705	78	1·720
7	12·058	31	9·099	55	5·550	79	1·563
8	12·266	32	8·975	56	5·393	80	1·400
9	12·298	33	8·848	57	5·235	81	1·245
10	12·200	34	8·718	58	5·076	82	1·092
11	12·043	35	8·585	59	4·916	83	0·949
12	11·865	36	8·448	60	4·755	84	0·860
13	11·678	37	8·309	61	4·593	85	0·782
14	11·481	38	8·165	62	4·432	86	0·716
15	11·274	39	8·017	63	4·263	87	0·662
16	11·056	40	7 865	64	4·093	88	0·646
17	10·845	41	7·714	65	3·914	89	0 614
18	10·656	42	7·567	66	3·733	90	0·563
19	10·490	43	7·423	67	3·550	91	0·452
20	10·342	44	7·276	68	3·366	92	0·337
21	10·222	45	7·126	69	3·181	93	0·185
22	10·118	46	6·972	70	2·995	94	0·085
23	10·012	47	6·813	71	2·810	95	0·015
24	9·905	48	6·650	72	2·627	96	...

Table X.

Showing the Value of £1 Annuity on *Three Joint* Lives, the difference of whose ages is 10 and 20 years, according to the Northampton Tables of Mortality, interest at 4 per cent.

Ages.			Value.	Ages.			Value.	Ages.			Value.
1	11	21	8·627	26	36	46	8·171	51	61	71	4·032
2	12	22	9·914	27	37	47	8·027	52	62	72	3·847
3	13	23	10·344	28	38	48	7·878	53	63	73	3·660
4	14	24	10·598	29	39	49	7·725	54	64	74	3·477
5	15	25	10·655	30	40	50	7·571	55	65	75	3·298
6	16	26	10·708	31	41	51	7·420	56	66	76	3·128
7	17	27	10·700	32	42	52	7·272	57	67	77	2·959
8	18	28	10·654	33	43	53	7·123	58	68	78	2·785
9	19	29	10·562	34	44	54	6·971	59	69	79	2·598
10	20	30	10·438	35	45	55	6·816	60	70	80	2·408
11	21	31	10·305	36	46	56	6·658	61	71	81	2·224
12	22	32	10·170	37	47	57	6·497	62	72	82	2·044
13	23	33	10·031	38	48	58	6·332	63	73	83	1·875
14	24	34	9·887	39	49	59	6·164	64	74	84	1·743
15	25	35	9·738	40	50	60	5·994	65	75	85	1·623
16	26	36	9·584	41	51	61	5·827	66	76	86	1·519
17	27	37	9·429	42	52	62	5·662	67	77	87	1·425
18	28	38	9·278	43	53	63	5·494	68	78	88	1·350
19	29	39	9·131	44	54	64	5·322	69	79	89	1·248
20	30	40	8·986	45	55	65	5·145	70	80	90	1·122
21	31	41	8·850	46	56	66	4·965	71	81	91	0·951
22	32	42	8·718	47	57	67	4·782	72	82	92	0·767
23	33	43	8·586	48	58	68	4·597	73	83	93	0·548
24	34	44	8·451	49	59	69	4·408	74	84	94	0·362
25	35	45	8·313	50	60	70	4·219	75	85	95	0·169

DUODECIMAL MULTIPLICATION

Is similar to Multiplication of Decimals, but it differs in respect to the scale of notation; the former decreasing in *twelvefold* proportion,—the latter, in *tenfold* proportion.

It is employed by artificers in finding the content of their work, the linear dimensions being taken in *feet, inches,* and *parts* or *twelfths of an inch.*

Rule. **Place the numbers so that feet may be below feet, inches below inches, etc., then multiply by the feet in the lower line as in Compound Multiplication; next multiply by the inches, but write the product one place nearer to the right hand; again, in the same way multiply by the parts, writing the product one place nearer to the right hand than the last: then add the separate products carrying at 12.**

Ex.—Multiply 5 ft. 7 in. 3 pt. by 7 ft. 8 in. 6 pt.

Having multiplied as directed in the rule, the result is 43 sq. ft., 2 twelfths of a sq. ft. (or 24 sq. in.), four 144ths of a sq. ft. (or 4 sq. in.), 7 twelfths of a sq. in., and six 144ths of a sq. in.; *i.e.*, 43 sq. ft. (24 + 4) sq. in. and ($\frac{7}{12} + \frac{6}{144}$) sq. in. = 43 square feet 28$\frac{5}{8}$ square inches.

5 ft.	7 in.	3 pt.		
7	8	6		
39	2	9		
3	8	10	0	
	2	9	7	6
43	2	4	7	6

	ft.	in.	pt.		ft.	in.
1.	48	6	0	×	3	4
2.	98	3	0	×	5	6
3.	548	5	0	×	7	11
4.	141	6	0	×	6	10
5.	891	5	0	×	9	8
6.	146	3	0	×	8	9
7.	678	4	8	×	7	11
8.	37	6	9	×	11	10
9.	35	11	10	×	10	11
10.	67	8	11	×	9	11
11.	87	6	8	×	11	10

	ft.	in.	pt.		ft.	in.	pt.
12.	83	4	5	×	9	10	0
13.	87	11	11	×	11	11	0
14.	78	11	4	×	7	8	3
15.	63	4	8	×	8	9	6
16.	91	4	9	×	9	7	9
17.	33	0	8	×	7	6	8
18.	55	8	7	×	72	0	8
19.	77	11	8	×	37	11	8
20.	88	10	4	×	48	10	0
21.	73	5	8	×	33	6	4
22.	96	8	9	×	55	11	9

ARTIFICERS' MEASURING.

Artificers take the dimensions of their work with a measuring line divided into feet and inches, or with the carpenter's rule.

Problem I. To find the area of a board.

Rule. Multiply the length by the mean breadth.

Ex.—Find the area of a board 10 ft. 4 in. long and 1 ft. 6 in. broad. Ans. 15 sq. ft. 72 sq. in.

Here, 10 ft. 4 in. × 1 ft. 6 in. = 15 sq. ft. 72 sq. in.

Required the content,

1. Of a board 12 ft. 6 in. long, and 1 ft. 3 in. broad.
2. Of a deal 57 ft. 8 in. long, and 2 ft. 7 in. 3 pt. broad.
3. Of a board 16 ft. 9 in. long, and 2 ft. 2 in. broad.
4. Of a board 20 ft. 4 in. long, 2 ft. 6 in. broad at one end, and 1 ft. 10 in. at the other.
5. Of a board 30 ft. 8 in. long, and mean breadth 3 ft. 4 in.
6. Of a deal of fir 18 ft. 10 in. long, and 1 ft. 4 in. 3 pt. broad.

Prob. II. To find the solid content of squared timber.

Rule. Multiply the mean breadth by the mean thickness, and the product by the length.

Ex.—Find the cubic content of a log of wood, 20 ft. long, 1 ft. 6 in. broad, and 2 ft. 4 in. thick. Ans. 70 c. ft.

Here, 20 ft. × 1½ ft. × 2⅓ ft. = 70 cubic feet.

Required the solid content,

1. Of a log of fir, the length 27 ft., the mean breadth 1 ft. 10 in., and the mean thickness 1¼ ft.
2. Of a log of oak 24 ft. 6 in. long, the mean breadth 1 ft. 1 in., and the mean thickness 1 ft. 1 in.
3. Of a stone 3 ft. 11 in. thick, 7 ft. 9 in. broad, and 13 ft. 8 in. long.
4. Of a log of mahogany 7 ft. 8¼ in. broad, 9 ft. 5⅓ in. thick, and 58 ft. 6 in. long.
5. Of a block of marble 4 ft. 8 in. long, 3 ft. 11 in. thick, and 2 ft. 3 in. broad.
6. Of a log of beech 19 ft., 4½ in. long, 2 ft. 3⅙ in. broad, and 9⅔ in. thick.

PROB. III. To find the solid content of round timber.

COMMON RULE. Multiply one-fourth of the mean girt by itself, and the product by the length.

NOTE 1. Tapering timber should be divided into pieces of 8 or 10 feet long; the contents of which should be computed separately, and added for the whole content.

2. The common rule gives the content too small by 3 feet on every 11 feet of solidity, yet it is universally used in practice, being originally introduced in order to compensate the purchaser of round timber for the waste occasioned by squaring it.

RULE II. Multiply one-fifth of the girt by itself, and the product by twice the length for the true content.

Ex.—Find the cubic content of a piece of round timber 8 ft. 6 in. long, and its mean girt 10 ft.

Here, by Rule I. 2½ ft. × 2½ ft. × 8½ ft. = 53⅛ c. ft.
" " II. 2 ft. × 2 ft. × 8½ ft. × 2 = 68 c. ft.

Find the content,

1. Of a piece of round timber 9 ft. 6 in. long, and its mean girt 14 ft.
2. Of a tree 24 ft. long, and its girts at the ends 14 and 2 ft.
3. Of a tree 50 ft. long, and its mean girt 7 ft.
4. Of a tree 48 ft. long, and its girts at the ends 60 and 18 in.
5. Of a tree 32 ft. long, and its girts at the middle of every 8 ft., 64, 56, 52, and 46 in.
6. Of a tree 17¼ ft. long, the girts at 5 different places being 9·43, 7·92, 6·15, 4·74, and 3·16 feet.

EXERCISES.

1. How many feet in the floor of a room 46 feet 8 inches long, and 25 feet 4 inches broad?
2. The floor of a room measured 74 feet 10 inches by 53 feet 3 inches; find its content.
3. A window measures 7 feet 8 inches 6 parts by 4 feet 9⅔ inches; how many square feet does it contain?
4. How many imperial gallons of water will a cistern contain, whose inside dimensions are 38 feet 6 inches, 23 feet 4 inches, and 11 feet 9 inches?
5. How many gallons will another contain whose dimensions are double of those in last example?

6. How many solid feet in a plank of wood 16 feet 11 inches long, 3 feet 9 inches broad, and 2 feet 10½ in. thick?

7. A log of wood, 14 feet 10 inches long, was sawed into 7 deals, each 2 feet 11 inches broad; how many square feet did they contain?

8. How many feet are there in 5 deals, 12 feet 8 inches long, and their breadths 2 feet 2 inches, 2 feet 8 inches, 3 feet 5 inches, 3 feet 9 inches, and 3 feet 11 inches?

9. What is the difference between the areas of the floors of two rooms; the one 36 feet 7 inches by 22 feet 10 inches, and the other 27 feet 11 inches by 19 feet 7 inches?

10. What is the solid content of a box, 7 feet 9 inches 3 parts long, 2 feet 3 inches 6 parts broad, and 1 foot 11 inches 11 parts thick?

11. How many yards of painting are in a room 45 feet 6 inches long, 24 feet 10 inches broad, and 13 feet 4 in. high; and how much does it cost, reckoning the white-washing of the ceiling at 1½d. per square yard, and the rest at 10½d. per square yard?

12. A house has 3 tiers of windows, 4 in each tier; the height of the under tier is 7 feet 8 inches, of the second 6 feet 10 inches, of the third 5 feet 3 inches, and their common breadth is 3 feet 10 inches; find the expense of glazing them at 1s. 4d. per square foot.

13. What is the expense of lining a water-cistern 2 feet 10 inches long, 2 feet 6 inches deep, and 2 feet broad, with sheet lead, 10 lb. to the square foot, at £1, 18s. 9d. p. cwt.?

14. A court-yard is 50 feet long and 40 feet 6 inches broad; what will the paving of it cost, at 3s. 7½d. per square yard?

15. How much plastering on a partition 7 feet 8 inches long and 10 feet 3 inches high, deducting a door 6 feet 3 inches by 2 feet 10 inches; and what will it cost at 5d. per square yard?

16. How many square yards of standard brick-work are in a wall 75 feet long, 15 feet 9 in. high, and 3 bricks thick?

NOTE. The standard for brick-walls is three half-bricks thick, and walls of any other thickness are reduced to standard by multiplying by the number of half-bricks in the thickness, and dividing by 3.

17. How many square yards of standard thickness are in a brick wall 2½ bricks thick, 46 feet 7 inches long, and 8 feet 4 inches high?

18. What should be charged for the workmanship of a house 36 feet long and 24 broad within the walls; the side-walls are 2 feet thick and 24 feet high, measured from the foundation; the gables are 3 feet thick and 16 feet higher than the side-walls to the bottom of the chimney stalks, which are 7 feet broad, 3 deep, and 8 high; and there are also 110 feet of vents; the ruble-work is at £2 per rood of 36 square yards standard thickness, and the vents are at 4d. per foot?

Note 1. One foot is added to the height of the side-walls, as an allowance for levelling. The standard thickness of stone walls being 2 feet thick, all others, either above or below that thickness must be reduced to the standard.

2. The content of the gable-ends is obtained by adding the breadth of the house on the outside to the breadth of the chimney-stalk, and multiplying the sum by half the height from the level of the side-walls to the bottom of the chimney-stalk, and the content of the chimney-stalks is obtained by multiplying half the girt by the height.

3. In taking the dimensions when workmanship only is concerned, they measure over both side-walls and gables, and make no deduction for voids; but when the tradesman furnishes all the materials, the length of the side-walls is taken on the outside, and the breadth of the gables is taken in the inside of the house, and all vacancies are deducted.

19. A house of 3 stories is 45 feet long and 28 feet broad within the walls, and the height from the foundation to the top of the side-walls is 30 feet; the gables rise 18 feet above the side-walls to the bottom of the chimney-stalks, which are 8 feet wide, 3 deep, and 10 high; the side-walls are 2½ feet thick, and the gables 3 feet thick; there are 2 doors in the sides, each 7½ feet by 4 feet; 12 windows in the sides and 6 in the ends, each 6 feet by 3½ feet; find the expense of the workmanship, and the materials at £10, 6s. 8d. per rood, allowing £2, 14s. per rood for levelling the side-walls.

MISCELLANEOUS QUESTIONS.

1. In a shoal of herrings 7 miles in length, 2½ in breadth, and 350 yards deep; how many herrings, allowing 172 to a solid foot; and how many casks would they fill, each containing 815?

2. £20, 6d. is to be divided among four classes of poor people; there are 7 in the first class, 9 in the second, 15 in the third, and 20 in the fourth; the share of the first is double that of the second, the second triple that of the third, and the third quadruple that of the fourth: required the share of each class.

3. A dealer in cloth carried to market 27¾ yards, which he sold at 2s. 11½d.; 35½ yards, of which he sold 26 yards at 15s. 10¾d.; and the remainder at 15s. 7½d.; 25 yards which he sold at 5s. 3¾d.; 3 pieces, each 26½ yards, of which he sold 52¼ yards at 6s. 8¼d., and the remainder at 6s. 9¾d.; his expenses amounted to 13s. 6d.; and he also paid a bill of £3, 17s. 6d.: how much cash did he bring home, supposing he had £1, 13s. 4d. when he went away?

4. A miller bought 1100 qrs. of wheat at 35s. 6d., and 175 qrs. barley at 22s.; the wheat produced 2¼ stones of flour per bushel, which he sold at 23½d. per stone; the barley produced 2⅞ stones per bushel, which he sold at 13¼d. per stone: find his gain upon the whole, allowing £4, 13s. for grinding and other expenses.

5. Reduce $\frac{4}{11}$ of 7⅓ of £4, 12s. 6d. to the fraction of £90, 3s. 9d., and express the result decimally.

6. A farmer possesses 24 acres at 25s. per acre, which is laid out in four equal divisions: The 1st is sown in wheat, and produces 5 qrs. per acre at 37s., seed 6 bushels per acre; 2d, barley produces 5 qrs. at 25s., seed 3½ bushels; 3d, oats produces 4¾ qrs. at 16s., seed 5 bushels; 4th, grass produces in all 160 stones hay, at 4¾d. per stone: what has the farmer for his expense of time and labour?

7. If an acre of ground produces 4½ qrs. wheat, and each peck gives 20 lb. of bread, how much ground will be necessary to supply a city of 5000 families with bread for a year, supposing each family uses 12 lb. per day; and how much would supply all the inhabitants of the United King-

dom with bread for the same time, taking their number at 29000000, and allowing each person 1¼ lb. per day?

8. Reduce 7 cwt. 3 qr. 17 lb. to the dec. of 12 cwt. 2 qr. 16 lb., and 8 ml. 7 fu. 9 po. to the dec. of 40 ml. 5 fu. 24 po.

9. A merchant sold 8 pieces of linen, each 27 yards, at 3s. 7d. per yard; 78 yards cotton, at 1s. 3d.; 4 pieces corduroys, each 30 yards, at 2s. 7d.; 5 pieces velvets, each 37 yards, at 3s. 2d.; but the buyer, being desirous of a year's credit, is willing to allow 5 per cent. for it: how much will he have to pay at the end of the year?

10. Bought a quantity of cloth for £412, 10s.; 85 yards getting damaged, were sold at 15s., whereby I lost £6, 7s. 6d.; but sold the remainder so as to gain £17, 16s. 8d. upon the whole; find the quantity bought, and at what rate the undamaged part was sold.

11. A bankrupt owed to his three creditors £48, 15s., £72, 10s., and £84, 13s. 4d.; his effects amounted to £100; divide it among his creditors according to their claims.

12. Received 125 yards of cloth, at 5s. 6d., for 215 lb. of tea; required the price of the tea.

13. A has 13 cwt. 21 lb. of hops, at 35s. per cwt., which he would barter with B for 10 sovereigns, 8 florins, 7 half-guineas, and brandy at 11s. 6d. per gallon; how much brandy must be given?

14. Bought goods to the value of £360, and sold them at £400, payable in 6 months; what was the gain or loss?

15. A barters with B 16 pieces of cloth, each 25 yards, at 10s. per yard, for 64 stones of wool, at 14s. per stone, and £80 in cash; the balance is to be paid in cotton, at 9d. per lb.: how many lb. must be given?

16. A gives B 3 cwt. 3 qrs. 15 lb. of tea, at 6d. per oz., for 400 gallons of wine; how was the wine rated per gal.?

17. A barters with B tea worth 5s. 6d., at 6s. 3d., for rum worth 7s., at 7s. 11d.; who has the advantage, and how much?

18. C barters with D 3 cwt. of tea, worth 7s. per lb., at 7s. 4d., for cloth worth 2s. 4d., at 2s. 6d.; who had the advantage in barter, and how much cloth did C get?

19. A cask of wine containing 55 dozen may be sold presently at 39s. per dozen; or 2½ years hence at 46s. 6d. per dozen; but besides losing the interest at 5 per cent.,

the leakage will be 2⅛ dozen, and other charges 17s.; what is the gain or loss by keeping it?

20. A values cloth in barter at 6s. 3d., worth only 5s. 9d.; how must B value cloth worth 7s. 2d. to be even with him?

21. A barters with B 102 lb. of tea, at 4s. 9d., 36 lb. ditto, at 3s. 6d., and 54 lb. ditto, at 7s. 4d., for 546 lb. of sugar, at £3, 8s. per cwt., 735 lb. ditto, at £4, 16s., and the balance in cash: how much cash was given?

22. A woollen manufacturer sold 3 pieces of broad cloth, each 27 yards, at 17s. 3d.; and 5 pieces of narrow ditto, each 31 yards, at 11s. 7d.; he allowed 5 per cent. discount for ready money: what did he receive?

23. Bartered 56½ lb. of tea, at 11s. 5d., for tobacco, at £7 per cwt.; how much tobacco did I receive, and at what rate per lb.?

24. Bartered 252 gallons of rum, and 120 gallons of brandy, for 17 cwt. 3 qrs. 23 lb. of tobacco, at £6, 18s. per cwt.; and 5 cwt. 19 lb. of sugar, at 15s. 6d. per quarter: find the price of the brandy and rum per gallon, the brandy being dearer by 1⅛s. per gallon.

25. A barters with B 750 quarters of wheat, at 39s. 6d. per quarter, for 540 quarters of barley, and £760, 10s. of money; what was the price of the barley?

26. A butcher agrees with a grazier to feed 30 oxen for a year, at £3, 5s. each; but at the end of 3 months the butcher adds 6 more, and at the end of 6 months 9 more; how long may the whole be continued for the sum already stipulated; and what will be due to the grazier if the whole are continued to the end of the twelve months?

27. The average price of the 30 oxen was £4, 5s., of the *six*, £5, 18s., of the *nine*, £6, 14s., and after fulfilling the original agreement, he feeds each with 18 pecks of corn, at 16s. 4d. per qr., and 24 trusses of hay, at 1s. 2d. per tr.; he slaughters them, and their average weight and price were as follow, viz., beef 32 stones, at 3¾d. per lb., tallow 5 stones, at 6½d. per lb., hide 1 guinea: find the gain or loss.

28. A contractor engages to supply a ship with provisions, and receives 15s. per month of 28 days, for each seaman, thrice as much for each officer, and 6 times as much for the captain. The crew consists of the captain, 8

officers, and 160 seamen. He provides 35 barrels beef, at 35s. 6d.; 16 ditto pork, at 52s.; 8 tons, 15½ cwt. of bread, at 25s. per cwt.; 82 bushels of pease, at 5s.; 26 cwt. 2 qrs. 21 lb. of cheese, at 30s. per cwt.; 18 cwt. 3 qrs. 16 lb. of butter, at £3, 14s. 8d. per cwt.; 26½ qrs. of oatmeal, at 19s.; 8 cwt. of fish, at 26s.; other small charges amount to £1, 7s. 3½d.; at the return of the ship he finds his profit is £185, 5s. 5d.: how long was the voyage?

29. Imported 120 jars of oil, each containing 1180 solid inches (231 inches = 7½ lb.); what did the freight come to at 5s. 3d. per cwt., deducting tare at 7 lb. per cwt.?

30. A privateer, consisting of a captain, first and second mates, a surgeon, a carpenter, 52 sailors, and 42 marines, took a prize of £31235⅜, of which the proprietors are to have ⅔, and of the remainder the captain is to have 9 shares, the first mate, surgeon, and carpenter, each 6⅓ shares; the second mate 5 shares; each sailor 1¼ share; and each marine ¾ of a share: how much will each get?

31. What is that gentleman's yearly income, who lets his estate of 24642 acres, at 11s. 8d. per acre?

32. A father left his estate to his wife and three sons, as follows:—To his eldest son ⅓ — £140, to his second son ¼ + £20, to his youngest son ⅕ — £220, and to his wife ⅕; find his estate and the share of each.

33. A bankrupt's effects amount to £1850; divide it among his six creditors, whose claims are to each other as the numbers 3, 5, 7, 9, 11, 13.

34. Four men, A, B, C, and D, got a present of a guinea, of which A claims ⅓, B ⅕, C ¼, D ⅙, but find it too little; determine their shares of it in the above proportion.

35. Three men, E, F, and G, entered into company; E continued his share of the stock for 4 months, and claimed ⅓ of the profits, F continued his for 9 months, G continued his stock of £550 for 8 months, and received ¼ of the gain; find E and F's stock.

36. Suppose a wolf could devour a sheep in an hour, a tiger do so in ½ hour, and a lion in ⅓ hour; and that the wolf eats 10 minutes by himself, after which the tiger arrives and eats along with him 10 minutes longer, then the lion arrives, and all three eat together: in what time will the sheep be devoured?

37. A man was engaged for 40 days, at 3s. 6d. per day; he forfeited 1s. 3d. for every day he was idle, and received only £5, 6s. 9d.; how many days was he idle?

38. What number is that, from which if $\frac{5}{23}$ of $6\frac{3}{11}$ be subtracted and $\frac{7}{11}$ of $6\frac{3}{5}$ be added to the remainder, the sum is 14·125?

39. In Fahrenheit's thermometer the freezing point is 32° and the boiling point 212°; in the Centigrade the freezing point is zero, and the boiling point 100°: what degree F. corresponds with 30° C., and what degree C. with 41° F.?

40. A gentleman, after spending $\frac{1}{2}$, $\frac{1}{5}$, and $\frac{1}{7}$ of his money, has £84, 10s. $9\frac{1}{2}$d. remaining; what sum had he at first?

41. What number, being increased by $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, and $\frac{1}{12}$ of itself, becomes 1927?

42. The 2d, 3d, and 4th terms of a proportion are 78, 39, and 26; what is the first term?

43. A person bought 360 apples, at 3 for 2d., and 240, at 2 for 1d.; he sold them at 5 for $3\frac{1}{2}$d.; what did he gain or lose on the whole?

44. Paid £807, 5s. $1\frac{3}{4}$d.$\frac{1}{2}$, for £725, 12s. 6d., borrowed $4\frac{1}{2}$ years since; what rate per cent. per annum was paid for the loan?

45. What number multiplied by ·00084 produces 15·246?

46. What sum will produce the same interest in 10 months that £648, 17s. 6d. produces in 6 months?

47. The rent of a fishery is £360; the tenant employs 8 men at 10d. per day, and an overseer at double wages; the fishermen have also $\frac{1}{6}$ of the fish: the fishing season continues for 249 days, and they catch on an average, 250 fish in 8 days—weight on an average 8 lb. each; the expense of boats and nets is £60; the fish are packed in barrels, each containing 300 lb., price of the barrels 2s. 6d., salt 1s. 6d.: at what must they be sold per barrel, that the tenant's gain may be $\frac{1}{5}$ of the whole?

48. A person has $\frac{3}{7}$ of a ship, worth £3150, he sells $\frac{4}{11}$ of his share to one person and $\frac{2}{3}$ of $\frac{9}{16}$ of the remainder to another; what part has he remaining, and what is its value and also that of the part sold?

49. A cistern has three spouts; by the first it can be filled in 24 hours, and by the second in 36, but by the third

it can be emptied in 30 hours; in what time could the cistern be filled, if the three spouts were all open?

50. A gentleman distributes £30, 9s. among his labourers; to each man he gives 4s. 6d., to each woman 3s. 6d., and to each boy 2s. 6d.; the men were to the women as 3 to 2, and the boys to the women as 1 to 4; how many were there of each?

51. What number multiplied by $\frac{7}{9}$ of $3\frac{3}{7}$ and the product divided by $\frac{4}{11}$ of $13\frac{3}{4}$ will give 248?

52. Reduce 8s. $1\frac{1}{2}$d. to the fraction of 14s. $7\frac{1}{2}$d., and 4 ton, 9 cwt. 3 qr. 23 lb. to the fraction of 19 ton, 19 cwt. 1 qr. 17 lb.; also express the results decimally.

53. What fraction when divided by $(\frac{4}{7})^3$ and multiplied by $\sqrt[3]{\frac{1728}{2197}}$ gives $68\frac{4}{7}$ for the result?

54. The 1st, 3d, and 4th terms of a proportion are 156, 91, and 42; what is the 2d term?

55. Borrowed £181, 13s. 4d., at $3\frac{1}{2}$ per cent., and paid for the loan £199, 3s. $0\frac{1}{2}$d.; how long had it been borrowed?

56. A city is supplied with water brought in pipes from three different fountains, at the distance of $1\frac{3}{4}$ mile, $2\frac{5}{8}$ miles, and $2\frac{7}{8}$ miles respectively; each foot of pipe weighs 12 lb. at $2\frac{3}{4}$d. per lb.; the expense of laying them is 13d. per yard; cisterns and other expenses £$45\frac{1}{3}$; 600 of the inhabitants agree to pay as much annually as will amount to the interest of the money expended, at 5 per cent.; how much must each pay?

57. The diameters of the bores of the pipes are $4\frac{1}{2}$ in., $5\frac{1}{4}$ in., and $6\frac{3}{4}$ in.; the first runs 4 gallons of water per minute, and the quantities supplied by the others are directly as the squares of their diameters. Now it was found that the number of families in the whole city was such, that each, supposing all to have the same quantity, would have exactly as many gallons per day as the first pipe furnished per minute; required the number of families.

58. How much timber is there in a log 3 feet 8 inches by 2 feet 11 inches, and $37\frac{1}{4}$ feet long?

59. In another 2 feet 10 inches by 1 foot 9 inches, and 33 feet long?

60. How much timber in a round tree 27 feet long, and girt in the middle 75 inches?

61. In another 31 feet long, and girt 55 inches?

62. In another 25 feet 6 inches long, and girt 37 inches?

63. In another 37 feet long, and girts in 3 places, 72 inches, 60 inches, and 54 inches?

64. In another 65 feet long, and girts 84 inches, 76 inches, 63 inches, 56 inches, and 46 inches?

65. How many square yards of wainscoting are in a room 68 feet in circuit, and 11 feet 2 inches high?

66. A bill of £384, 15s. 5d., dated January 15th, at 3 months, was discounted March 8th at 4 per cent.; find the net proceeds.

67. After drawing from a cask of wine $\frac{1}{4}$, $\frac{1}{3}$ of the remainder was then drawn, again $\frac{1}{5}$ of the remainder, and again $\frac{1}{6}$ of the remainder, after which 108 gallons were left; how many gallons could the cask contain?

68. How many sq. yds. of wainscoting are in a room 37 feet long, 25 broad, and 9 feet 8 inches high?

69. In another 74 feet in circuit, 12½ feet high, allowing work and half for a door 6 feet 9 inches, by 2 feet 10 inches, and for 2 windows with shutters, each 5 feet 8 inches by 3½ feet, deducting a vacancy for a chimney 6 feet 3 inches by 5 feet 6 inches?

70. Find the square roots of 400080004 and $\frac{1573}{1872}$.

71. Invested £6313, 2s. 6d. in the 3 per cents. at 92½, and sold out at 93; what difference will it make in my income to reinvest the proceeds in the 4 per cents. at 97½?

72. How many squares (each 100 square feet) of flooring in a house of 5 floors, 64 feet by 34, within the walls, deducting from each floor the vacancy for the stair, 12 feet 3 inches by 8 feet; and what is the value at 46s. per square?

73. How many yards of painting in a room 38 feet long, 23½ broad, and 11½ feet high, deducting the chimney, 4 feet 8 inches by 3½ feet; and how much does it come to at 20d. per yard?

74. A can do a piece of work in 8 days, which B can do in 12 days; after A has worked 2 days B comes to help him: in what time will they finish it?

75. Find the cube root of 8242652826424008.

76. How many yards of plastering on a wall 24 feet long, and 12 feet 9 inches high?

77. How many roods (rood = 36 square yards) of mason-work in a wall 36 feet long and 15 feet high?

78. A cubic foot of water weighs 62½ lbs. avoir.; what weight of water is in a cistern 10 ft. 6 in. long, 6 ft. 4 in. wide, and 1 foot 3 in. deep?

79. A piece of ground 88 yards long, contains exactly 1 acre; what is its breadth?

80. How many roods are in a wall 108 feet long, and 22½ feet high; and how much did it cost, at 32s. per rood?

81. What is the expense of a wall 27 feet long, 24 feet high, and 3 feet thick, at 30s. per rood?

82. How many yards of brick-work are in a wall 56 feet long, 24 feet high, and 2½ bricks thick?

83. In what proportions should tea at 3s. 4d. and 4s. per lb. be mixed, to sell it at 3s. 6d. per lb.?

84. The sum of the incomes of A and B is £1065, 9s. 2d., and their difference is £85, 15s. 10d.; what is the income of each?

85. After paying income tax at 7d. per £, and other taxes at 1s. 3d. per £ on the remainder, £2184, 7s. 6d. was left; what was the original amount?

86. How many yards of brick-work are in a wall 125 feet long, 14 feet 8 inches high, and 2½ bricks thick?

87. How many feet of hewn work are in a stone 13 feet 6 inches by 3 feet 8 inches?

88. Find the diagonal of a square, whose side is 750 yds.

89. What is the difference between the simple and compound interest of £336, 13s. 4d. for 4 years at 2½ p. cent.?

90. How many feet of hewn work are in 8 stones, each 12 feet 4 inches by 5 feet 9 inches?

91. What will the paving of a street come to at 6½d. per yard, its length being ¾ mile, and breadth 66½ feet?

92. The corn produced by a field was found to be 250 qrs., or ¼ more than what was sown; how much was sown?

93. A person being asked his age, replied if to my age you add ⅕ and ⅛ of it, the sum will be 53; what was his age?

94. What will the glazing of 9 windows come to at 9¾d. per foot, three 6½ feet high, three 5½ feet, and the remaining three 4¾ feet high, and their breadth 3 feet 8 inches?

95. How many deals, 33 feet by 8 inches, will floor a room 33 feet by 28 feet?

96. How many yards of plastering are in 3 rooms, the first 24 feet by 16½ feet, the second 34½ feet by 21 feet 9 inches, the third 40 feet by 34 feet, their common height 10½ feet, deducting 3 doors, each 6½ feet by 3 feet; and what is the value, the ceilings being reckoned at 8d., and the walls at 3d. per yard?

97. How many deals, 15 feet long, and 1½ foot broad, will floor a room 60½ feet by 33½ feet?

98. How many solid yards of digging in a cellar 24 feet long, 13½ feet broad, and 3 yards deep?

99. What will the digging of the foundation of a house, 68 feet long, 33 feet broad, and 5 feet deep, amount to at 15d. per solid yard?

100. A bankrupt can pay 13s. 4d. per £1, but the expenses attending his failure are £316, 14s. 2d., and then he can only pay 12s. per £1; find the amount of his debts.

101. A merchant bought 84 yards of cloth for £61, 13s. 4d., he gave 13s. 4d. per yd. for part of it, and 16s. 8d. per yd. for the rest; how many yards of each did he buy?

102. A garrison of 2500 men was provisioned for 24 days; after 16 days it was reinforced, and then the rations were exhausted in 5 days; how many men were in the reinforcement?

103. Ninety half-crowns and florins amount to £11, 3s. 6d.; how many are there of each?

104. Three troops of cavalry start from the same place at the rate of 3½, 4, and 4½ miles an hour; the second starts 3 hours after the first; how long after the second should the third start to overtake the first at the same time?

105. A cistern is filled by three pipes in 40 minutes; the first conveys 9 gallons less, and the second 15 gallons more than the third per minute; the cistern contains 2640 gallons; how many gallons per minute does each pipe convey into the cistern?

106. A can do a piece of work in 6 days, which A and B can do in 4 days; how long after B should A begin, so that, finishing it together, each may have done half the work?

107. If the weight of mercury be to that of water, as 13½ to 1, and a cubic foot of water weigh 62½ lb.; and the height of the mercury in the barometer (the weight of

which is equal to the weight of a column of air on the same base, extending to the top of the atmosphere) be 30 inches; what is the weight of the air upon a man's body, which measures generally about 15 square feet; and what is the whole weight of the atmosphere, the earth's surface being 198943750 square miles?

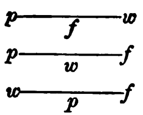
108. If the proportion of sea to land upon the surface of the earth be as 21 to 10, and the mean depth of the sea 2 miles; what will be the weight of the whole body of water in the sea, and what will be the weight of the whole body of salt and other particles wherewith it is impregnated, the weight of sea to pure water being as 103 to 100?

109. Bar gold in London is £3, 17s. 9d. per oz. standard; required the arbitrated rate of exchange produced by its export to the United States, for coinage at the rate of 232⅕ grains of fine gold for the eagle of 10 dollars.

110. Bar silver in London is 5s. per oz. standard; in Amsterdam it is 104½ florins per pond fine; the pond being equal to 1000 wigties, and 31·1002 wigties equal to 1 oz. troy; required the arbitrated rate of exchange between London and Amsterdam.

NOTE. There are three sorts of levers according to the different situations of the power, the fulcrum or prop, and the weight as in the annexed diagram. Now, in all the mechanic powers, the momentum of the power is equal to the momentum of the weight; or, in other words, the power multiplied into its velocity is equal to the weight multiplied into its velocity. Therefore, putting $p =$ power, $w =$ weight, $D =$ the distance between the power and fulcrum, and $d =$ distance between the weight and fulcrum, then $p \times D = w \times d$; whence $p = \frac{w \times d}{D}$, $w = \frac{p \times D}{d}$.

$$D = \frac{w \times d}{p}, \text{ and } d = \frac{p \times D}{w}.$$



111. Let $p = 5$, $D = 100$, $d = 10$, $w = 50$, considering any three of these as given; required the others.

112. Let $p = 5$, $D = 110$, $d = 10$, $w = 55$, considering any three of these as given; required the others.

113. Let $p = 55$, $D = 10$, $d = 110$, $w = 5$, admitting that any three are given, the fourth is required.

114. At what distance from the fulcrum of a steel-yard must a pound weight be suspended, to balance 3lb., 4 lb., 5 lb., etc., hung at 4 inches distance from the other?

115. A beam of 8 inches radius, winding a rope with a bucket round it, is driven by the help of a wheel of 4 feet radius; what force will be necessary to raise 63 gals. of water, when a solid foot weighs $62\frac{1}{4}$ lbs.?

NOTE. A heavy body falling from rest will fall $16\frac{1}{12}$ feet in the first second of time; and the spaces described from the beginning of motion are as the squares of the number of seconds.

116. What space will a heavy body, falling freely, pass through in 9 seconds?

117. In what time would a stone, falling from the top of a precipice 600 feet high, reach the ground?

118. How far will a body descend, in free space, in 20 seconds?

119. I reckoned 7 strokes of my pulse during the fall of a stone from the top of a rock; what height did it fall, the pulse beating 70 times in a minute?

NOTE. Sound in common air moves uniformly at the velocity of 1142 feet per second.

120. I observed the flash of a gun 30 seconds before I heard the report; how far was it distant?

121. How long after firing a gun, will the report be heard at the distance of 7 miles?

NOTE. The degrees and effects of light, heat, and attraction, are reciprocally proportional to the squares of their distances from the centre whence they are propagated.

122. The distance of Mercury from the sun being reckoned 37 millions of miles, of Venus 69 millions, of the Earth 95 millions, of Mars 145 millions, of Jupiter 495 millions, of Saturn 907 millions, and of Uranus 1823 millions; find the proportion of the sun's light, heat, and attraction on all these bodies.

DECIMAL COINAGE.

The propriety of introducing a Decimal Coinage into this country having for some time been under the consideration of Government, the system most likely to be adopted is given in the following table.

TABLE OF DECIMAL MONEY.

1 mil (*m.*)			= £$\frac{1}{1000}$	= $\frac{24}{25}$f.
10 mils =	1 cent (*c.*)		= £$\frac{1}{100}$	= 2$\frac{2}{5}$d
100 mils =	10 cents =	1 florin (*fl.*)	= £$\frac{1}{10}$	= 2s.
1000 mils =	100 cents =	10 florins	= £1	= 20s.

6d. = 25m. = 2c. 5m.; 1s. = 50m. = 5c.; 2s. 6d. = 125m. = 1fl. 2c. 5m.; 5s. = 250m. = 2fl. 5c.; 10s. = 500m. = 5fl. etc.

The pound sterling would then be divided into 1000 equal parts, instead of 960 parts, as it now is, and calculations in money would be performed as in Simple Numbers, due care being taken to separate the pounds from the florins, cents, and mils by a point.

Ex. 1. Express £9, 5fl. 8c. 2m.; £10, 8c. 5m., and £12, 4fl. 3m. as decimals of £1.

Here,	£9,	5fl.	8c.	2m.	is written	decimally,	£9·582
„	10	0	8	5	„	„	10·085
„	12	4	0	3	„	„	12·403

Write decimally,

1.	£79,	2fl.	5.	£110,	7fl.	8c.	9.	£153,	9fl.	8c.	6m.
2.	97	5	6.	101	0	9	10.	135	8	0	2
3.	69	8	7.	136	5	2	11.	315	0	4	0
4.	96	6	8.	163	4	0	12.	513	0	0	7

Ex. 2. Express £72·874 in £s, florins, etc. Ans. £72, 8fl. 7c. 4m.

Express in £s, florins, etc.,

13.	£84·200	17.	£123·007	21.	£572·867
14.	48·340	18.	132·174	22.	257·480
15.	96·257	19.	213·305	23.	752·025
16.	108·025	20.	312·048	24.	572·009

ADDITION, SUBTRACTION, MULTIPLICATION, AND DIVISION.

Rule. Write the amounts decimally, proceed as in the four Simple Rules, and point off *three* figures from the right of the result.

Ex. 3. Find the sum of £75, 8fl. 5m., £57, 5c. 8m., and £63, 8m.; also the difference between £108, 2fl. 7m. and £59, 3fl. 7c. 8m.

£75, 8fl. 5m. = £75·805
£57, 5c. 8m. = 57·058
£63, 8m. = 63·008
Sum, £195·871

£108, 2fl. 7m. = £108·207
£59, 3fl. 7c. 8m. = 59·378
Difference, £48·829

Ex. 4. £17, 8fl. 2c. 4m. × 73; £396, 2fl. 1c. 6m ÷ 36.

£17·824
73
53472
124768
Product, £1301·152

36 { 6)£396·216
6)66·036
Quotient, £11·006

25. £45, 3fl. 2c. 5m. + £54, 6fl. 2m. + £37, 5c. + £73, 2m. + £79, 5fl. 6c. + £97, 8fl. 2m. + £111, 1fl. 2c. 3m.

26. £148, 5c. 8m. + £418, 5fl. 7m. + £184, 9fl. 8c. 7m. + £418, 6m. + £841, 7c. 8m. + £481, 6fl. + £814, 5fl. 8c. 2m.

27. £784, 2fl. 4m. + £874, 5c. 7m. + £487, 9fl. 2c. 8m. + £847, 2m. + £748, 3c. + £478, 5fl. 8m. + £500, 8fl. 7c. 6m.

28. £956, 2c. 4m. + £596, 3fl. 7c. + £965, 7fl. 6c. 5m. + £695, 7m. + £569, 2fl. 6m. + £659, 6fl. 5c. 4m. + £729, 7c.

29. £327, 3fl. 2c. 5m. + £237, 2fl. 6m. + £273, 3c. 4m. + £723, 8m. + £732, 9fl. + £372, 8fl. 9c. 8m. + £379, 2fl. 6m.

30. £568, 7fl. 8c. 6m. + £586, 7m. + £658, 5c. + £685, 9fl. 8m. + £856, 8c. 6m. + £865, 4fl. 5c. 6m. + £984, 3fl.

31. From £836, 5fl. 8m. take £397, 6fl. 7c. 9m.

32. Take £348, 7fl. 8c. from £836, 6fl. 5c. 7m.

33. From £872, 8fl. 3c. 2m. take £384, 9fl. 7c. 8m.

34. Take £397, 7fl. 9m. from £482, 3fl. 7c. 6m.

35. From £916, 3c. take £429, 7fl. 6c. 5m.

36. Take £419, 4fl. 7c. 5m. from £718, 2fl. 6c. 3m.

37. £28, 3fl. 9m. × 27
38. £37, 6fl. 7c. 4m. × 49
39. £73, 8fl. 5c. × 72
40. £84, 5fl. 6c. 8m. × 96
41. £67, 7c. 9m. × 99
42. £84, 2fl. 6c. 3m. × 110

43. £95, 1fl. 8m. × 63
44. £59, 6fl. 8c. 7m. × 144
45. £7, 8fl. 9c. 6m. × 19
46. £9, 7fl. 8m. × 23
47. £12, 7c. 3m. × 47

48. £15, 7m. × 95
49. £24, 3fl. 7c. 5m. × 101
50. £37, 8c. 6m. × 243
51. £48, 9fl. 4m. × 313
52. £73, 6fl. 2c. 7m. × 379

53. £209, 3fl. 7c. 6m. ÷ 24
54. 266 6 2 5 ÷ 27
55. 401 5 5 5 ÷ 35
56. 562 4 0 8 ÷ 44
57. 777 8 9 6 ÷ 56
58. 995 2 1 1 ÷ 63
59. 1165 9 9 5 ÷ 81
60. 1041 8 7 6 ÷ 132

61. £338, 6fl. 5c. 6m. ÷ 19
62. 566 8 5 2 ÷ 26
63. 1010 7 2 9 ÷ 37
64. 734 2 9 8 ÷ 46
65. 1596 8 3 8 ÷ 89
66. 1482 0 5 4 ÷ 98
67. 1214 3 7 9 ÷ 123
68. 3785 7 8 0 ÷ 292

Ex. 5. Reduce £14, 19s. 9d. from the present to the decimal system.

By Contraction 3, p. 91, £14, 19s. 9d. = £14·9875

Reduce from the present to the decimal system,

69. 8s. 6d.
70. 12 3
71. 13 4
72. 15 9
73. 17 6
74. 18 4

75. £4, 2s. 6d.
76. 7 3 9
77. 9 16 8
78. 10 15 6
79. 14 16 3
80. 19 17 8

81. £29, 5s. 7½d.
82. 47 6 8
83. 59 8 5
84. 79 16 3
85. 85 15 6
86. 98 1 8

Ex. 6.—Reduce £17, 5fl. 7c. 5m. from the decimal to the present system.

By Contraction 4, p. 92, £17·575 = £17, 11s. 6d.

Reduce from the decimal to the present system,

87. 6fl. 2c. 5m.
88. 7 7 5
89. 8 5 4
90. 3 7 5
91. 9 8 3
92. 5 1 6

93. £4, 5fl. 8c. 3m.
94. 7 6 6 6
95. 9 8 3 3
96. 12 3 3 3
97. 14 9 3 5
98. 17 6 8 3

99. £29, 9fl. 5c. 4m.
100. 47 7 1 5
101. 58 5 8 2
102. 77 3 2 8
103. 84 4 8 3
104. 99 0 3 3

PRACTICAL EXERCISES.

1. A gentleman's annual income is £525, 8fl. 7c. 5m.; his expenses amount to £375, 9fl. 8c. 6m.: how much does he save in the year?

2. What should be paid for 37 lbs. of sugar at 3c. 7m. per lb.?

3. If 67 yards of cloth cost £82, 7c. 5m.; what is the price per yard?

4. The yearly rent of a house is £92, 3fl.; how much is it weekly?

5. What should be paid for 57 quarters of wheat, at £2, 3fl. 7c. 5m. per quarter?

6. Divide £505, 7c. 5m. among 89 men?

7. What is the weight of a piece of silver, which cost £34, 3fl. 7c. 5m., at 2fl. 7c. 5m. per oz.?

8. If 17 cwt. of sugar cost £36, 1fl. 2c. 5m.; what should 183 cwt. of the same cost?

9. How many yards of cloth, at 2fl. 2c. 5m. per yard, should be given for 243 yards, at 1fl. 8c. 7½m. per yard?

10. Find the value of 1 cwt. of sugar, when 5 cwt. 18 lb. cost £13, 5m.

11. If the quartern loaf costs 3c. 7½m. when wheat is at £3, 5fl. per qr.; what should it cost when wheat is at £2, 8fl. per qr.?

12. A bankrupt's effects amount to £5756, and he compounds with his creditors for 6fl. 2c. 5m. per £1; what is the amount of his debts?

13. If 45 men earn £125, 1fl. 5c. 6m. in 10 days; how many men will earn £187, 7fl. 3c. 4m. in 15 days?

14. In what time will the interest of £525, 3fl. 7c. 5m. pay a debt of £87, 5fl. 6c. 2½m. at 5 per cent. per annum?

15. If 24 men consume £6 worth of bread in 15 days, when the loaf is at 3c. 2m.; what value of bread will 56 men consume in 25 days, when the loaf is at 2c. 4m.?

16. What part of £23, 6fl. 5c. 2m. is £13, 7fl. 9c. 7m.?

17. Reduce £7, 6fl. 1c. 6m. to the decimal of £14, 8fl. 7c. 5 m.

18. Find, by Practice, the value of 12 cwt. 3 qrs. 14 lbs. of tea, at £19, 6fl. per cwt.

19. What is the interest on £574, 6fl. for 4½ years at 3½ per cent. per annum?

20. Required the amount of £5760, 8fl. for 2 years, 4 months, at 2¼ per cent.

21. Find the interest on £1533 for 240 days at 3¼ per cent.

22. What is the amount of £520, 1fl. 2c. 5m. for 2 years and 120 days, at 4 per cent.?

23. What sum will amount to £188, 2c. 5m. in 2 years, 3 months, at 4 per cent.?

24. What discount should be allowed for present payment of £763, 3fl. 4c. 4m. due six months hence, at 2½ per cent.?

25. Find the present value of £187, 7fl. 7c. 5m., due 219 days hence, at 2½ per cent.

26. If £775, 8fl. 7c. 5m. amounts to £1024, 1fl. 5c. 5m. in 8 years; what rate per cent. is charged for the loan?

27. In what time will the interest of £2053, 1fl. 2c. 5m. pay a debt of £100, 8fl. at 3½ per cent.?

28. What must be paid for insuring £7050, at 1fl. 7c. 5m. per cent.?

29. How much should be paid for £948, 5fl. 1c. 2m. 3 per cent. stock, at 92½, brokerage 1fl. 2c. 5m. per cent.?

30. How much must be invested in the 3 per cents. at 92¼, to produce an annual income of £245, 2fl. 5c. 6m.

31. A person has £5000 in the 3 per cents.; how much must he invest in the 3½ per cents. at 93¼ to have an income of £399, 9fl. per annum?

32. A grocer mixes 12 lbs. of tea at 2fl. 2c. 5m. with 15 at 2fl., 20 at 1fl. 7c. 5m., and 24 at 1fl. 5c.; how should the mixture be sold per lb. to clear 8fl. 3c. 2m.?

33. A bankrupt owes to A, £420, 6fl. 2c. 5m.; to B, £342, 3fl. 7c. 5m.; to C, £497, 3fl. 2c. 5m.; to D, £508, 6fl. 7c. 5m.; and to E, £542, 1fl. 2c. 5m.; his effects amount to £1774, 9fl. 4c. 4m.: how much will each receive?

34. Divide £1383, 9fl. 3c. 6m. among A, B, C, and D, giving A 4 as often as B 3, C 2 as often as B 3, and D 3 as often as C 5.

35. Divide £474, 2fl. 9c. 2m. among 4 persons, so that ⅐ of the 1st, ⅓ of the 2d, ¼ of the 3d, and ⅙ of the 4th, may each make the same sum.

36. Bought 3 casks of sugar, each 3 cwt. 2 qr. 14 lb., at 2c. 5m. per lb.; what should the whole be sold for to gain 6fl. per cwt.?

37. Bought goods for £613, 2fl. 5c. 6m.; how should they be sold to gain 7$\frac{1}{2}$ per cent.?

38. A person's income is £525; how much has he left after paying a tax of 7c. 5m. per £ upon it?

39. Find the difference between the simple and compound interest of £450, 6fl. 7c. 5m. for 4 years, at 4 per cent.

40. What is the present value of £756, 8fl. 5m., due 3 years hence, at 3 per cent. per annum, compound interest?

41. What is the amount of an annuity of £45, payable yearly for 5 years, at 4 per cent. per annum, compound interest?

42. How many £s, florins, cents, and mils, and the same number of each, are contained in £809, 9fl. 1c. 9m.?

43. The sum of the incomes of 2 persons is £1005, 4fl. 8c. 9m., and the difference is £45, 7fl. 5c. 9m.; what is the income of each?

44. By selling coffee at £9, 3c. per cwt., 7$\frac{1}{2}$ per cent. is gained; how much is gained per cent. by selling it at £9, 1fl. 5c. 6m. per cwt.?

45. How many yards of cloth at £1, 2fl. 7c. 5m. should be given for 85 cwt. of sugar at £2, 8fl. 5m. per cwt.?

46. A person, after spending $\frac{1}{3}$ and $\frac{2}{5}$ of his income, has remaining £97, 2fl. 8c. 4m.; what was his income at first?

47. A person has $\frac{5}{7}$ of a ship worth £4576, 3fl. 2c.; he sold $\frac{1}{4}$ of his share to one man, and $\frac{2}{3}$ of the remainder to another: what part has he left, and what is its value?

48. A father left $\frac{5}{12}$ of his estate to his son, and the remainder to his daughter; the difference of their fortunes was £675, 5fl. 2c. 4m.: what was the value of his whole estate?

49. Lost 8 per cent. by selling an article for £16, 6fl. 7c. 5m., and recovered the loss by selling another for £37, 7fl.; what was the gain per cent. on the second article?

THE METRIC SYSTEM

DERIVES its name from the *metre*, which is the unit of length, and is the ten-millionth part of a quadrant of the meridian, or the ten-millionth part of the distance between the poles and the equator.

The principle on which it is founded is, that *ten* of any name make *one* of the next higher name; hence arithmetical operations in this system are performed as in simple numbers.

In the following tables, the unit of length is the *metre;* of surface, the *are;* of solidity, the *stere;* of capacity, the *litre;* and of weight, the *gram.* The Latin derivates—*deci*, tenth of; *centi*, hundredth of; and *milli*, thousandth of—are prefixed to the several units to denote their subdivisions: while the Greek derivatives—*deca* or *deka*, ten; *hecto*, hundred; *kilo*, thousand; and *myria*, ten thousand—are prefixed to the several units to denote their multiples.

TABLES OF THE METRIC OR DECIMAL SYSTEM.

I. Measures of Length.

10 millimetres = 1 centimetre = ·394 inches.
10 centimetres = 1 decimetre = 3·937 „
10 decimetres = 1 metre = 39·371 „
10 metres = 1 dekametre = 10·936 yards.
10 dekametres = 1 hectometre = 109·363 „
10 hectometres = 1 kilometre = 1093·633 „
10 kilometres = 1 myriametre = 6·2138 miles.

100 yd. = 91·438 metres; 100 ml. = 160·932 kilometres.

Long distances are stated in kilometres.

II. Measures of Surface.

10 centiares = 1 deciare = 11·960 sq. yards.
10 deciares = 1 are = 119·603 „
10 ares = 1 dekare = 39·538 sq. poles.
10 dekares = 1 hectare = 2·471 acres.

100 square metres = 1 are.
100 square yards = 83·610 square metres.
100 square poles = 25·292 ares.
100 acres = 40·467 hectares.

Large surfaces are stated in hectares.

III. Measures of Solidity.

10 centisteres = 1 decistere = 3·532 cu. feet.
10 decisteres = 1 stere = 35·317 „
10 steres = 1 dekastere = 353·167 „

1 cubic metre = 1 stere; 1 dekastere = 13 c. yards.

IV. Measures of Capacity.

10 centilitres = 1 decilitre = ·704 gill.
10 decilitres = 1 litre = 1·761 pint.
10 litres = 1 dekalitre = 2·201 gallons.
10 dekalitres = 1 hectolitre = 2·751 bushels.
10 hectolitres = 1 kilolitre = 3·439 quarters.

1 cubic decimetre = 1 litre = 61 cu. inches nearly.

100 gallons = 454·346 litres.
100 bushels = 36·348 hectolitres.

V. Measures of Weight.

10 milligrams = 1 centigram = ·154 grain.
10 centigrams = 1 decigram = 1·543 „
10 decigrams = 1 gram = 15·432 „
10 grams = 1 dekagram = 5·644 drams av.
10 dekagrams = 1 hectogram = 3·527 ounces „
10 hectograms = 1 kilogram = 2·205 pounds „
10 kilograms = 1 myriagram = 22·046 „ „

1 cubic centimetre of distilled water, at its greatest density, weighed in a vacuum = 1 gram.

100 kilograms = 1 quintal; 1000 kilog. = 1 millier.
100 lb. av. = 45·359 kilograms; 100 tons = 101·605 milliers.

VI. Measures of Value.

10 centimes = 1 decime.
10 decimes = 1 franc = 9½d. ster. nearly.

The par of exchange with London, deduced from the gold coins, is 25 francs 22½ centimes per £1. The decime is seldom mentioned, accounts being kept in francs and centimes.

EXERCISES ON THE METRIC SYSTEM.

1. How many centimetres are in a hectometre?
2. How many millimetres are in a myriametre?
3. Express 9·754 kilom., in metres and in millimetres.
4. Write in words—9·6 metres; 39·45 m.; 4075·395 m.

5. How many centiares are in 1000 hectares?
6. How many square metres are in a dekare?
7. Express 753 hectares, 84 centiares, in ares.
8. Write in words—497 ares; 734·8 ares; 975·45 ares.

9. How many centisteres are in 500 dekasteres?
10. How many cubic decimetres are in a dekastere?
11. Express 95 dekasteres, 75 decisteres, in steres.
12. Write in words—575 steres; 57·5 steres; 5·75 steres.

13. How many decilitres are in 5 hectolitres?
14. How many cubic centimetres are in 10 kilolitres?
15. How many cubic centimetres are in 12 dekalitres?
16. Express 45 kilolitres, 75 litres, 25 centilitres, in litres.
17. Express 125 hectolitres, 175 centilitres, in centilitres.
18. Write in words—9654 litres; 94·25 litres; 375 litres.
19. Write in words—7954 centil.; 46875 millilitres.

20. How many decigrams are in a kilogram?
21. How many milligrams are in a dekagram?
22. How many centigrams are in 10 hectograms?
23. Express 75 hectog., 25 decigrams, in grams.
24. Express 4 dekagrams, 75 centigrams, in milligrams.
25. Express 9 kilog. 7 dekag. 4 decig., in centigrams.
26. Express 8 milliers, 7 quintals, in grams.
27. Write in words—735·75 grams; 9754·25 grams.
28. Write in words—37500 decig.; 74895 centigrams.
29. Write in words—37546 centig.; 369548 millig.

30. How many centimes are in 375 francs?
31. Write in words—756·25 francs; 3456·75 francs.

Find the sum of,—

32. 8 kilometres, 7 dekametres, 5 decimetres; 84 hectometres, 7 metres, 75 millimetres; 95 dekametres, 7 decimetres; 9 metres, 5 millimetres; 975·025 metres.

Find the sum of,—

33. 7·269 metres; 3·459 dekametres; 7·895 hectometres; 3·498 metres; 3·75 decimet.; 9·4375 kilomet.

34. 347 hectares, 5 deciares; 25 ares, 75 centiares; 8 dekar. 3·25 ares; 375 hectar. 95 deciar.; 732·45 deciar.

35. 657·35 hectares; 369·25 ares; 67545 deciares; 3595 centiares; 453·9 dekares; 9·75 ares.

36. 14·375 steres; 24·25 dekasteres; 47·5 decisteres.

37. 7·475 kilolitres; 95·75 hectolitres; 754·3 dekal.; 754·5 litres; 8·2475 kilol.; 35·425 hectol.; 43·75 litres.

38. 37 kilol.; 147 hectol.; 475 dekal.; 143·75 litres; 450 decil.; 1375 centil.; 73 kilol.; 195·35 litres.

39. 74 kilog.; 375 hectog.; 3475 dekag.; 4375 grams; 3756 decig.; 37543 centig.; 34568 milligrams.

40. 3456 francs, 75 cents.; 4563 fr. 25 cents.; 3475·95 fr.; 2575 fr. 4 cents.; 7459 fr. 25 cents.; 75955 cents.

41. 75 kilom. 56 metres—175 hectom. 25 decim.
42. 74375·25 ares—575 hectares, 15·75 ares.
43. 495 dekasteres, 75 centist.—396 dekast. 25 decist.
44. 745 kilol. 45 lit. 8 centil.—59 kilol. 5 dekal. 9 centil.
45. 947 kilog. 75 dekag. 75 decig.—174 kilog. 96 dekag. 765 centig.—56·79565 kilograms.
46. 4 milliers, 375·04 grs.—247·75 kilog. 3·75 gr.
47. 3756 francs, 25 cents.—1797 fr. 7 dec. 8 cents.
48. 8954 francs, 26 cents.—5985 fr. 96 cents.

49. 2 dekam. 25 decim. 25 millim. × 16, 37, 42·5
50. 25 hectares, 215 centiares × 24, 43, 3·75
51. 34 dekast. 895 centisteres × 56, 62, 47·5
52. 25 kilol. 127·45 litres × 72, 79, 2·45
53. 4 myriag. 147 gr. 75 centig. × 81, 89, 3·42
54. 2 quintals, 125·75 grams × 96, 101, 4·25
55. 4375 francs, 75 cents. × 99, 111, 2·47

56. 4 kilom. 27 metres, 75 centim. ÷ 25, 47, 2·45
57. 47 kilol. 75 dekal. 375 centil. ÷ 45, 63, 24·5
58. 3347 kilog. 25 dekag. 475 centig. ÷ 60, 73, 36·5
59. 37 milliers, 147 kilog. 75 grams ÷ 40, 31, 3·65
60. 37458 francs, 75 cents. ÷ 35, 43, 79·3

ANSWERS.

SIMPLE ADDITION.

1. 20828
2. 18031
3. 15220
4. 16803
5. 24005
6. 30888
7. 37961
8. 27601
9. 413608
10. 407219
11. 45293750
12. 258329412
13. 275849956926
14. 452986
15. 213207895
16. 1870302861
17. 48272491
18. 318769662
19. 54540
20. 55055
21. 69502121
22. 318725
23. 190572575
24. 244121066

1. 45293750
2. 258329412
3. 275849956926
4. 172486693
5. 467607538
6. 100615850
7. 364061525
8. 910634531
9. 10202566290
10. 715048145489126
11. 8959706158610
12. 98951852130430
13. £210229
14. 25124 trees
15. £2024
16. £2024
17. £70603560
18. 5868 years
19. £1996
20. £26468
21. £33390
22. 7587045
23. 5267 foot
    1100 horse

SIMPLE SUBTRACTION.

1. 3814
2. 1176
3. 471
4. 486
5. 462
6. 999
7. 47739
8. 44549
9. 171139
10. 5293750
11. 23798657
12. 69147873734
13. 995896
14. 1985846
15. 34827583
16. 486792836
17. 5196382
18. 9182735
19. 8765433
20. 85936428
21. 8628475
22. 347636
23. 5497919
24. 81726355
25. 68004
26. 72486693
27. 4676075
28. 7788490
29. 90858897
30. 1006158
31. 3640615
32. 91063453
33. 7369286
34. 69968419
35. 1020256629
36. 71504814548
37. 999977689
38. 895970615861
39. 989518521304

1.	£4674	8.	Pres. ye. — 1519	13.	562 horse;
2.	39 years		Diff. + 604		3635 foot
3.	In 1816	9.	487 years	14.	6942 feet
4.	£7329	10.	£1881	15.	18966818
5.	£2894	11.	£1530	16.	440 yd.
6.	17 years	12.	802151385	17.	2818145000 ml.
7.	£1261			20.	In 1769

18, 19, 21, 22, Pres. year — dates in these Exercises.

SIMPLE MULTIPLICATION.

CASE I.

203670942860277
271561257147036
339451571433795
407341885720554
475232200007313
543122514294072
611012828580831
678903142867590
746793457154349
814683771441108

1.	1804599297	13.	2763308592	25.	7378240711125
2.	27535765810	14.	73997918611	26.	456817937112
3.	31624816	15.	7425028227636	27.	549937660552
4.	53055442	16.	2958421180572	28.	3275126400000
5.	48964815	17.	2408397120	29.	51643431600000
6.	37012312	18.	4822150080	30.	3853670873940
7.	341591710	19.	448349273425	31.	50594581803480
8.	659198664	20.	29062914930	32.	326034810684
9.	50205818	21.	72027758680	33.	59944850490
10.	29382630	22.	574585614865	34.	264998300000
11.	864472245	23.	67254023544	35.	2963100000000
12.	69748500	24.	68118176511	36.	58543382524158

CASE II.

1.	141294366	7.	62913396	13.	63209856
2.	16299552	8.	7799936	14.	17156544
3.	30329574	9.	33945600	15.	658538928
4.	47932390	10.	38525809	16.	874621260
5.	5299672	11.	78801336	17.	760070976
6.	41358060	12.	12790092	18.	1627531080

1.	7740 sheaves	6.	224 sq. ft.	11.	2646
2.	2655 letters	7.	18480 stones	12.	122640 miles
3.	£33984	8.	666225000 grs.	13.	15300 men
4.	£1872	9.	56940 strokes	14.	63952 ft.
5.	£9648	10.	31680 sq. yds.	15.	525600 min.

16. 18135 ml. | 17. 24884160 letters

SIMPLE DIVISION.

CASE I.

1. 4678949
2. 495108
3. $342926\frac{8}{25}$
4. 78460839
5. $8098754\frac{38}{59}$
6. 91468937
7. 78460839
8. $858850\frac{18}{79}$
9. 91468937
10. $3923244\frac{32}{89}$
11. 91468937
12. 91468937
13. $763973\frac{81}{98}$
14. $6801816\frac{760}{809}$
15. 91468379504
16. 6789456
17. $80455464\frac{220}{897}$
18. 247567
19. 317649
20. 2706915
21. 147678
22. 73581
23. $1711\frac{3065}{8709}$
24. $1786\frac{913}{8778}$
25. $899\frac{75424}{87146}$
26. 764258
27. 5648736
28. $144171\frac{6200}{67800}$
29. 12076849
30. 1460900
31. 2768000
32. $4050010\frac{8696837}{10748047}$
33. 207008009

CASES II. AND III.

1. 3919575231
$1959787615\frac{2}{4}$
1306525077
$979893807\frac{6}{8}$
$783915046\frac{2}{10}$
$653262538\frac{6}{12}$
2613050154
$1567830092\frac{2}{5}$
$1119878637\frac{3}{7}$
871016718
712650042
2. 3421376990
1710688495
$1140458996\frac{2}{3}$
$855344247\frac{1}{2}$
$570229498\frac{1}{3}$
$622068543\frac{7}{11}$
$760305997\frac{7}{9}$
$977536282\frac{6}{7}$
1368550796
$2280917993\frac{1}{3}$
684275398
3. 1782
4. $2074\frac{36}{72}$
5. $198\frac{40}{144}$
6. $17691\frac{20}{28}$
7. $457\frac{56}{64}$
8. $10313\frac{9}{81}$
9. 78504
10. 907356
11. 3891468
12. 7553344
13. 784689
14. $155610\frac{5}{16}$
15. $203318\frac{20}{24}$
16. $19935\frac{39}{49}$
17. $9493\frac{12}{81}$
18. $44433\frac{56}{154}$
19. $24559\frac{49}{343}$
20. 63425

---

1. £445 each
2. 760 pages
3. 111 trees
4. £$15\frac{2}{13}$ per wk.
5. £67 each
6. 20 ft. long
7. 521 herrings
8. 8465
9. $582\frac{22}{24}$ miles
10. 675 times

SUPPLEMENT TO MULTIPLICATION AND DIVISION.

CASE I.

1. 37917
2. 50274
3. 6610$\frac{1}{2}$
4. 6877
5. 3260$\frac{2}{5}$
6. 4095$\frac{5}{6}$
7. 7209$\frac{1}{8}$
8. 12415$\frac{1}{2}$
9. 18445
10. 9592$\frac{4}{9}$
11. 62$\frac{1}{11}$
12. 10041$\frac{5}{12}$
13. 871690873$\frac{9}{15}$
14. 325669443$\frac{21}{23}$
15. 251529982$\frac{22}{31}$
16. 943593841$\frac{17}{35}$

CASE II.

1. 164104$\frac{8}{9}$
2. 83568$\frac{8}{35}$
3. 149498$\frac{13}{19}$
4. 11967$\frac{7}{31}$
5. 628$\frac{33}{54}$
6. 75423$\frac{61}{91}$
7. 35411$\frac{90}{164}$
8. 2457$\frac{475}{1461}$
9. 22757$\frac{99}{179}$
10. 446975$\frac{179}{275}$
11. 116219$\frac{80}{866}$
12. 489699$\frac{321}{628}$

CONTRACTIONS IN SIMPLE MULTIPLICATION.

1. 182410
2. 2396750
3. 33919500
4. 941145
5. 10190700
6. 73914000
7. 184650
8. 2368000
9. 509550
10. 29775
11. 1240500
12. 73050000
13. 98592
14. 145741
15. 94582
16. 571584
17. 397712
18. 492890
19. 943313
20. 714000
21. 801751
22. 91532
23. 815958
24. 58764
25. 7502583
26. 84321379
27. 285381
28. 58828
29. 7604832
30. 37026
31. 96903
32. 3358416
33. 3969603
34. 2799972
35. 5249475
36. 56718654
37. 9788473098
38. 4466526
39. 468412172
40. 55677584
41. 40872087
42. 30677871
43. 60185834
44. 7280896
45. 16383168

CONTRACTIONS IN SIMPLE DIVISION.

1. 75647
2. 49958$\frac{24}{30}$
3. 189194$\frac{56}{100}$
4. 166746$\frac{64}{70}$
5. 86154$\frac{4}{110}$
6. 54358$\frac{4}{10}$
7. 4999$\frac{156}{300}$
8. 794$\frac{9232}{10000}$
9. 16653$\frac{3}{90}$
10. 3787$\frac{128}{1000}$
11. 5810$\frac{22}{270}$
12. 658$\frac{1368}{3000}$

13. $3839\frac{1}{12}$ | 14. 629 | 15. $181\frac{4}{13}$

16. $740168\frac{815}{1000}$ | 17. $654\frac{128}{10000}$ | 18. 75384

19. $8821\frac{420}{548}$ | 21. $1428\frac{540}{8475}$ | 23. $35\frac{259}{8153}$

20. 5672 | 22. $876\frac{218}{6789}$ | 24. $72\frac{1476}{7916}$

COMPOUND NUMBERS.

REDUCTION.

REDUCTION OF MONEY.

Cases I. and II.

The Answers to the First Twelve Questions are the Numbers given in the next Twelve, and *vice versa*.

Case III.

1. £88851
2. 75156 gu. 4s.
3. 1143355 fl.
4. 48020610 fl. 1s. 6d.
5. £750414
6. 524501010 fourp.
7. £18289195
8. 1306247 h.-gu. 2s. 6d.
9. 10440000d.
10. 63000 fourp.
11. 359 h.-crs. 2s. 2d.
12. £933, 2s. 6d.
13. 299160 gu. 20s.
14. 89114220 h.-gu. 10s.
15. £381450640, 4s.
16. 2526940 dol. 3s. 4d.
17. £70676, 17s. 6d.
18. 862182 h.-gu. 3s.
19. 943362 twop.
20. 16960 pieces
21. 133345 cr. 4s.
22. 4705722 fl.
23. 13663 gu. 2s.
24. 894 cr. 3s.
25. 3456 pieces

REDUCTION OF WEIGHTS AND MEASURES.

1. 573440 drs.
2. 32625341 drs.
3. 975629 drs.
4. 1568 oz.
5. 6922 drs.
6. 501775 oz.
7. 18832 to. 16 c. 2 q. 18 lb. 13 o.
8. 31 c. 3 q. 16 lb. 15 oz. 2 d.
9. 31 cwt. 1 qr. 3 lb. 1 oz.
10. 220 qr. 25 lb. 8 oz.
11. 1869 lb. 14 oz. 10 dr.
12. 2552 to. 6 c. 15 lb. 12 o.
13. 5760 grs.
14. 2793551 grs.
15. 5610552 grs.
16. 5301 grs.
17. 92 oz.
18. 86472 grs.

19. 192 lb.
20. 13 lb 8 oz. 10 dwt. 8 gr.
21. 854 lb. 6 dwt. 3 gr.
22. 1015 oz. 12 dwt. 8 gr.
23. 6243072 lb. 10 oz.
24. 6800 lb. 1 oz. 11 dwt.
25. 5760 grs.
26. 3968657 grs.
27. 225888 scr.
28. 2730 lb. 10 oz. 5 dr. 1 scr.
29. 649 lb. 7 oz. 5 dr. 1 s. 15 gr.
30. 95279 lb. 11 oz. 2 dr.
31. 119804 nls.
32. 1764378 in.
33. 150 h.-nls.
34. 49042 yds. 2 qrs.
35. 49010 yds. 2 qrs.
36. 1177109 qrs. 1 nl.
37. 98083 yds. 3 qrs.
38. 44925 Eng. ells
39. 59763 yds.
40. 731708 Eng. ells
41. 17537898 Fl. ells
42. 4979636 Fr. ells, 4 qrs.
43. 2280960 lines
44. 138893005672960 yds.
45. 8933844 lines
46. 20998 ml. 4 fu. 14 po. 1 yd. 1 ft.
47. 44837863 ml. 34 yds.
48. 487294 ml. 580 yd. 2 ft.
49. 748480 per.
50. 92577 per.
51. 3794802 yds.
52. 76618 per.
53. 2993530 ac.
54. 24686723 ro. 26 per.
55. 4028238 ro. 17 p. $3\frac{3}{4}$ yd.
56. 112292 ac. 2 ro. 24 per. 6 s. yd. 8 s. ft.
57. 381024 sq. in.
58. 252 sq. yds.
59. 49312 sq. in.
60. 684 sq. ft. 128 in.
61. 11337408 cu. in.
62. 297 cu. yds.
63. 17263785815 gall.
64. 4333 pts.
65. 4536 qts.
66. 1462 qr. 3 b. 3 pk. 1 qt.
67. 2147 qr. 3 b. 1 gal. 3 qt.
68. 9074738 sec.
69. 3 signs 14° 23′ 27″
70. 1764053 sec.
71. 2446307 sec.
72. 16 c.yd. 1 c.ft. 469 c.in.
73. 3419019 cu. in.
74. 17811665849 cu. in.
75. 50182 gall.
76. 3136 qrs. 3 pks.
77. 2449407 pts.
78. 1715 qrs. 6 bu. 4 pts.
79. 62204459 sec.
80. 8766 ho.
81. 1893415800 thirds
82. 31557600 sec.
83. 6 ye. 1 da. 10 ho. 53 min. 45 s. 54 th.
84. 31556930 sec. × pres. year
85. 19 Ju. ye. 4 d. 16 h. 40 m.
86. 15 Ju. ye. 126 da. 5 h. 44 min.

EXERCISES UNDER THE NOTE.

1. £756
2. 1205 yards
3. 6956 yards
4. 800 gu.
5. 612 E. ell.

COMPOUND ADDITION.

	£	s.	d.
1.	343	0	4
2.	1470	9	11½
3.	2688	8	0
4.	3824	3	3¾
5.	63	16	2
6.	66	2	1¼
7.	928	8	9
8.	4825	5	9¾
9.	70395	5	6
10.	55862	0	4
11.	50650	6	5¾
12.	99153	10	2¼
13.	320717	5	11
14.	1952045	4	1¼

15. 306 to. 18 cwt. 3 qr.
16. 135 lb. 5 oz. 15 dr.
17. 268c. 3qr. 13lb. 12oz. 3dr.
18. 287 lb. 7 oz. 15 dwt. 14 gr.
19. 105 lb. 6 oz. 5 dwt. 13 gr.
20. 49 lb. 7 dr. 2 scr.
21. 46 yd. 2 qr. 3 nl.
22. 38 le. 1 ml. 3 fu. 35 po.
23. 118 pol. 3 yd. 2 ft. 10 in.
24. 120 ac. 9 per.
25. 48 ac. 29 per. 10¼ yds.
26. 80 qr. 4 bu. 3 pk.
27. 25 pk. 1 gal. 3 qt.
28. 364 bu. 1 pk. 1 gal. 3 qt.
29. 308 qr. 7 bu.
30. 87s. 21° 32′ 28″
31. 271 ho. 8 m. 45 sec.
32. 902 da. 8 ho. 37 m.
33. 3797 c. yr. 40 d. 23 h. 1 m.
34. 473 Ju. ye. 338 da.

35. £4270, 1s. 0d.
36. £3516, 12s. 11d.
37. 2862 yd. 1 qr. 1 nl.
38. £12, 6s. 5¼d.
39. £3296, 18s. 8¼d.
40. £764, 9s.
41. £966, 2s. 5d.
42. £3223, 18s. 11d.
43. £8884, 1s. 7d.
44. 11169c. 1q. 14lb. 1oz. 14d.
45. £1750, 4s. 3d.
46. 77 lb. 8 dwt. 18 gr.
47. 3721 ac. 2 ro. 10 per.
48. £281, 5s. 4d.
49. £39338, 16s. 6½d.

COMPOUND SUBTRACTION.

	£	s.	d.
1.	9	8	10
2.	8	17	5
3.	94	15	5¾
4.	816	17	8½
5.	17846	17	8
6.	4738	17	2
7.	3109	0	11
8.	7148	11	8½
9.	9148	11	9¼

	£	s.	d.
10.	87191	11	7½

11. 56 c. 3 q. 26 lb. 14 oz. 14 dr.
12. 8 yd. 3 qr. 1 nl.
13. 58 lb. 11 oz. 15 dwt. 18 gr.
14. 4 lb. 11 oz. 7 dr. 2 sc. 11 g.
15. 8 qr. 3 bu. 2 pk. 1 gal. 7 pt.
16. 14 m. 7 f. 34 po. 4 y. 2 f. 11 in.
17. 7 ac. 1 ro. 18 per. 15 yd.
18 47 Ju. y. 260¼ d. 1 h. 48 m.

19. £5960, 14s. 3¾d.
20. £817, 17s. 6d.
21. £3195, 1s. 5d.
22. £1755, 17s. 3d.
23. 1 oz. 3 dwt. 12 gr.
24. 2 lb. 5 oz. 15 dwt. 3 gr.
25. 3 c. 1 q. 11 lb. 6 oz. 14 d.
26. £433, 18s. 10½d.
27. 265 ac. 3 ro.
28. 107 hhds. 3 gals.
29. 81 hhds. 4 pts.
30. £3677, 19s. 6d.
31. £3439, 17s. 7d.
32. 60 cwt. 1 qr. 20 lb.
33. 248 cwt. 1 qr. 10 lb.
34. A, £34, 8s. 9½d.
B, £29, 17s. 10¼d.
C, £25, 12s. 11¾d.
35. £132, 2s. 3¾d.
36. £112, 8s. 5¼d.

COMPOUND MULTIPLICATION.

Case I.

	£	s.	d.
1.	12	19	10½
2.	37	13	5
3.	449	13	9
4.	6	1	2¼
5.	144	7	4
6.	159	15	2¼
7.	132	16	0½
8.	0	4	4¼
9.	60	2	6
10.	87	0	3¾
11.	3	7	4½
12.	198	3	10¾
13.	840	11	6
14.	803	7	4
15.	9	16	8
16.	491	17	0
17.	812	15	0¼
18.	695	8	0

19. 68 cwt. 3 qr. 22 lb.
20. 174 lb. 2 oz. 7 dr.
21. 219lb. 8oz. 10dwt. 12gr.
22. 899 lb. 8 oz. 4 dr.
23. 151 tons, 2 cwt.
24. 79 lb. 1 oz. 15 dr.
25. 79 lb. 8 oz. 9 dwt. 6 gr.
26. 381 ml. 9 po. 4½ yd.
27. 24799 gal.
28. 23 bu. 1 pk. 6 pt.
29. 221 qr. 7 bu. 1 peck
30. 31 ye. 5 mo. 21 da.
31. 21 da. 15 ho. 50 min.
32. 134 ac. 3 ro. 31 per.
33. 94 ac. 1 ro. 34 per.
34. 4382 da. 21 h. 47 m. 24 s.
35. 50103 gal. 2 qt. 1 pint
36. 35872 gal. 2 qt.
37. 2645 per. 28¾ yd. 8 ft.

Case II.

	£	s.	d.
1.	1134	13	1½
2.	351	13	9
3.	498	13	6
4.	1255	10	0
5.	50	4	6
6.	3	4	6
7.	570	0	0
8.	451	0	0
9	579	10	3
10.	825	12	0
11.	3279	1	3
12.	83	18	3
13.	255	3	0
14.	1344	12	0
15.	655	10	2
16.	907	4	0
17.	2817	12	0
18.	2898	0	0

19. 568 cwt. 1 qr. 16 lb.
20. 409 lb. 6 oz. 8 dr.
21. 1621 lb. 4 oz. 15 dwt. 13 gr.
22. 1583 ac. 2 ro. 12 per.
23. 1500 mls. 6 pol.
24. 2374 yd. 1 qr. 1 nl.

CASE III.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	56	19	4¼	6.	4596	3	2¾	11.	3635	12	8
2.	92	6	8½	7.	1213	15	8	12.	1155	19	0
3.	287	2	6¾	8.	2093	15	5¼	13.	5281	6	8
4.	19	12	0¾	9.	34	10	3¾	14.	2458	13	0
5.	984	0	8	10.	55	4	4½	15.	1176	14	0

16. 452 lb. 6 oz. 18 dwt. 6 gr.
17. 811 cwt. 3 qr. 20 lb. 12 oz.
18. 878 ml. 1 fu. 1 yd.
19. 2108 yd. 3 qr. 1 nl. 1 in.
20. 3193 ac. 4 per. 27¼ yd.
21. 5090 qr. 2 bu. 1 pk. 1 gal.

CASE IV.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	20162	19	6	5.	492710	1	8	9.	170058	17	11
2.	345772	11	6	6.	799993	6	0	10.	4034	5	4
3.	394643	15	0	7.	157365	5	10½	11.	2771	2	1½
4.	13738	1	8½	8.	10709	2	3	12.	3214	7	2¼

	£	s.	d.		£	s.	d.		£	s.	d.
1.	35	8	9	17.	55	8	1½	33.	410	0	6
2.	6	10	6¼	18.	223	3	9	34.	2127	11	4
3.	7	7	4¼	19.	122	0	2½	35.	23	4	9½
4.	10	12	6	20.	199	7	0	36.	3	15	3
5.	7	8	5¼	21.	153	11	7	37.	46	8	9¾
6.	9	16	10½	22.	20	9	0¾	38.	56	14	6½
7.	10	1	2¼	23.	306	18	1½	39.	413	18	10½
8.	24	14	2	24.	37	16	2	40.	148	18	1½
9.	42	9	6	25.	3	17	6	41.	75	12	0
10.	61	16	4½	26.	5	3	1½	42.	20	13	3
11.	78	19	4½	27.	76	18	3	43.	123	4	7
12.	78	1	4	28.	40	5	0	44.	6	19	0¾
13.	91	5	4½	29.	38	14	2	45.	988	11	10½
14.	100	13	11½	30.	27	4	6	46.	69	5	5
15.	145	17	6	31.	28	1	9	47.	172	19	6
16.	223	5	0	32.	100	5	11½	48.	123	5	0

49. 312c. 2q. 17lb. 6oz. 3dr.
50. 292 lb. 9 oz. 6 dwt.
51. 163lb. 11 oz. 14dwt. 9gr.
52. 13 lb. 4 oz. 5 dr. 19 gr.
53. 10lb. 10 oz. 12dwt. 6gr.
54. 79 pol. 5 yd. 1 ft.
55. 428 ac. 1 ro. 5 pe. 19 yd.
56. 459 qr. 5 bu. 3 pk.
57. 365866 gal. 3 qt. 1 pt.
58. 9240294 gal. 1 qt. 1 pt.
59. 1620 ml. 2 fu. 14 po.
60. 17 ye. 11 mo. $25\frac{1}{2}$ da.

COMPOUND DIVISION.

CASE I.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	1	1	$7\frac{1}{4}\,\frac{11}{17}$	8.	14	9	10	15.	9	9	$5\frac{1}{2}$
2.	1	4	0	9.	4	16	$3\frac{1}{2}$	16.	11	8	$3\frac{1}{2}\,\frac{22}{49}$
3.	0	8	$0\frac{1}{4}$	10.	6	12	$1\frac{1}{4}$	17.	3	4	$0\frac{1}{4}$
4.	0	11	$0\frac{1}{4}$	11.	6	8	$5\frac{1}{4}$	18.	0	18	$9\frac{3}{4}$
5.	0	17	$8\frac{3}{4}$	12.	10	14	3	19.	0	17	$11\frac{1}{2}$
6.	4	8	$1\frac{5}{38}$	13.	5	7	$6\frac{3}{4}$	20.	12	18	$11\frac{1}{2}$
7.	6	8	$9\frac{3}{4}\,\frac{5}{13}$	14.	1	10	$0\frac{3}{4}\,\frac{31}{79}$	21.	0	13	$7\frac{1}{4}$

22. 21 lb. 3oz. 15dwt. 21gr.
23. 17 yd. 2 ft. 11 in. 8 li.
24. 17 ml. 3 fu. 14 po.
25. 8 qr. 7 bu. 3 pk.
26. 14 yd. 2 qr. 3 nl.
27. 5 ac. 3 ro. 7 per.
28. 3 qr. 3 bu. $2\frac{13}{37}$ pk.

CASE II.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	14	9	$8\frac{1}{4}$	6.	11	9	$2\frac{1}{8}$	11.	0	13	8
2.	5	12	11	7.	149	17	11	12.	6	14	4
3.	159	14	8	8.	0	17	$3\frac{3}{4}$	13.	1	8	$5\frac{1}{2}\,\frac{1}{3}$
4.	14	12	7	9.	62	7	$2\frac{1}{2}$	14.	73	17	$8\frac{3}{4}$
5.	7	16	$6\frac{1}{4}\,\frac{1}{7}$	10.	21	15	$0\frac{1}{4}$	15.	0	14	11

16. 29 lb. 8 oz. 1 dwt. 18 gr.
17. 5 lb. 8 oz. 2 dr.
18. 1lb. 11oz. 7dr. 1sc. 14gr.
19. 14 yd. 2 qr. 3 nl.
20. 21 lb. 3oz. 19dwt. 10gr.
21. 17 yd. 2 ft. 11 in.
22. 17 yd. 2 ft. 11 in. 8 li.
23. 17 ml. 3 fu. 14 po.
24. 14 yd. 2 qr. 3 nl.
25. 9 qr. 3 bu. 2 pk.
26. 8 qr. 5 bu. 3 pk.
27. 7 cwt. 2 qr. 18 lb.
28. 15 lb. 3 oz. 5 dr.
29. 6lb. 2oz. 7dr. 2sc. 10gr.
30. 4 ac. 2 ro. 7 per.
31. 37 to. 15 cwt. 2 qr.
32. 15 lb. 13 oz. 3 dr.

CASE III.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	0	6	1	9.	0	4	$11\frac{1}{2}$	17.	1	16	0
2.	1	16	1	10.	1	4	$10\frac{1}{4}$	18.	0	18	$11\frac{1}{2}$
3.	0	15	$8\frac{1}{2}\ \frac{2}{3}$	11.	0	1	$10\frac{1}{2}$	19.	0	18	0
4.	9	1	2	12.	0	7	$10\frac{1}{2}$	20.	0	7	6
5.	4	18	$6\frac{1}{2}$	13.	2	14	0	21.	0	1	$10\frac{3}{4}$
6.	166	1	$5\frac{3}{4}\ \frac{3}{11}$	14.	1	1	4	22.	0	5	6
7.	8	8	0	15.	3	2	0	23.	0	4	10
8.	0	15	9	16.	1	11	6	24.	0	3	$9\frac{1}{2}$

25. 7 qr. 3 bu. 2 pk. 1 gal.
26. 21 lb. 3 oz. 15 dwt. 21 gr.
27. 17 yd. 2 ft. 11 in. 8 li.
28. 17 ml. 3 fu. 14 po.
29. 5 ac. 3 ro. 7 per.

CASE IV.

1.	43	4.	108	7.	103
2.	42	5.	703	8.	4880
3.	56	6.	7081	9.	365
		10.	348		

1. £0, 7s. $8\frac{3}{4}$d. per yd.
2. £0, 7s. $8\frac{3}{4}$d. per yd.
3. £0, 14s. $8\frac{1}{4}$d. per lb.
4. £0, 19s. $4\frac{1}{2}$d. per ac.
5. 7 cwt. 2 qr. 18 lb.
6. £123, 6s. 8d. per man
7. £125, 9s. 0d. loss of each
8. A man's share 10s. 0d.
   A woman's „ 3s. 4d.
9. £0, 12s. $9\frac{1}{2}$d. per yd.
10. £5, 12s. 9d. for 8 yd.
11. 3 cwt. 1 qr. 19 lb.
12. 7 bu. 3 qt. 1 pt. in 7 casks
13. 45 yards in each piece
14. 37 oz. weight
15. 17 poor persons.
16. 648 patients
17. 706 feet of wood
18. In 59 weeks
19. 1s. $5\frac{1}{32}$d. per week

SUPPLEMENT TO COMPOUND MULTIPLICATION AND DIVISION.

	£	s.	d.		£	s.	d.
1.	32	5	$4\frac{1}{2}$	9.	10	2	$5\frac{3}{4}\ \frac{10}{13}$
2.	18	12	$4\frac{3}{4}$	10.	9	1	$1\frac{1}{2}\ \frac{3}{8}$
3.	312	18	$5\frac{1}{4}\ \frac{1}{2}$	11.	8	15	$4\frac{1}{4}\ \frac{13}{47}$
4.	415	10	$7\frac{1}{4}\ \frac{7}{8}$	12.	7	13	$0\frac{3}{4}\ \frac{43}{47}$
5.	1203	18	$11\frac{1}{2}\ \frac{2}{9}$	13.	19	2	$11\frac{1}{4}\ \frac{116}{178}$
6.	2171	5	$7\frac{1}{5}$	14.	12	12	$10\frac{1}{4}\ \frac{17}{140}$

7. 36 cwt. 3 qr. $6\frac{2}{3}$ lb.
8. 61 qr. 4 bu. 2 pk. $1\frac{3}{5}$ pt.
15. 3 cwt. 2 qr. $15\frac{12}{23}$ lb.
16. 5 ac. 3 ro. $12\frac{2}{7}$ per.

QUESTIONS ON THE PRECEDING RULES.

1. £4, 17s. 10$\frac{1}{2}$
2. £9, 3s. 11$\frac{3}{4}$d. $\frac{1}{4}$
3. 18 cwt. 20$\frac{1}{4}$ lb.
4. 12s. 11d. per yd.
5. £3, 19s. 1$\frac{1}{2}$d. $\frac{64}{71}$, per cwt.
6. £71, 14s. 10d. a man's sh.
   £35, 17s. 5d. a boy's 〃
7. 3729 yds.
8. 207$\frac{141}{1461}$ ye.
9. 334 moons 21 da.
10. 133 En. ells 2$\frac{1}{25}$ qr.
11. 2642 ft. 5 in.
12. 240 Sc. ells
13. 24$\frac{199}{345}$ yds. in a piece
14. £2, 4s. 4$\frac{1}{2}$d. $\frac{30}{73}$, daily exp.
15. 12s. 0$\frac{1}{4}$d. $\frac{11}{13}$, wkly. exp.
16. £48
17. £2252, 18s. 6d.
18. 4308 gu. 7s.
19. 83185 dol. 2s. 6d.
20. 697342 yd. 3 in.
21. 66880 francs
22. 6175 dollars
23. 19395 fl. 1s. 8d.
24. £23989, 10s. 3d. lost
25. 83 lb. 1 oz. 2 dwt.
26. 110 hhds. sugar
27. 240 canisters
28. 1424087568 Sc. ells
29. 1585267200 in.
30. 431942346 in.
31. 66 of each
32. 232 qr. 2 bu. 2 pk.
33. 88 days in 1 revolution
34. 137280 revolutions
35. 6911136 letters
36. 65 cwt. 3 qr. 6 lb.
37. £3, 2s. 10$\frac{1}{2}$d. a man's sh.
    £1, 11s. 5$\frac{1}{4}$d. a woman's 〃
    £0, 10s. 5$\frac{3}{4}$d. a child's 〃
38. 75 of each
39. 1 cwt. 1 qr. 17 lb.
40. 16 lb. 1 oz. 12 dwt.
41. 3 cwt. 1 qr. 26 lb.
42. 24 cwt. 1 qr. 21 lb.
43. 172 cwt.
44. 309 cwt. 17 lb. 13 oz.
45. 32 cwt. 3 qr. 25 lb. 12 oz.
46. 14s. 6$\frac{1}{2}$d. per yd.
47. 4s. 4$\frac{1}{2}$d. $\frac{5}{8}$, per yd.
48. £3, 11s. 0d. gain
49. £6, 11s. 1d. saves
50. £11, 8s. 1$\frac{1}{2}$d. saves
51. £11, 1s. 0d. saves
    £1, 7s. 4$\frac{1}{26}$d. wkly. exp.
52. £574, 12s. 6d. gain
53. £87, 3s. 9d. loss
54. £59635, 6s. 0d. stock.

THE GREATEST COMMON MEASURE.

1. 16
2. 15
3. 17
4. 143
5. 144
6. 156
7. 191
8. 1470
9. 343

THE LEAST COMMON MULTIPLE.

1. 504
2. 540
3. 672
4. 360
5. 68640
6. 5040
7. 29172
8. 1591744

VULGAR FRACTIONS.

REDUCTION OF VULGAR FRACTIONS.

PROBLEM I.

$4\frac{3}{8}$; $6\frac{1}{3}$; $14\frac{1}{4}$; $15\frac{3}{7}$; $12\frac{5}{8}$; $7\frac{1}{2}$; $11\frac{1}{7}$; $13\frac{2}{5}$; $12\frac{13}{19}$; $15\frac{1}{25}$, $366\frac{10}{13}$.

PROBLEM II.

$\frac{35}{8}$; $\frac{19}{3}$; $\frac{57}{4}$; $\frac{108}{7}$; $\frac{101}{8}$; $\frac{15}{2}$; $\frac{78}{7}$; $\frac{67}{5}$, $\frac{241}{19}$; $\frac{376}{25}$; $\frac{4768}{13}$.

PROBLEM III.

$\frac{1}{10}$; $\frac{5}{112}$; $1\frac{3}{7}$; $\frac{36}{95}$; $2\frac{2}{3}$; $\frac{15}{44}$; 14; 32.

PROBLEM IV.

$\frac{4}{11}$; $\frac{3}{10}$; $\frac{528}{6452}$; $\frac{4332}{4493}$; $\frac{148}{1735}$; $\frac{191}{1310}$; $\frac{161}{432}$; $\frac{3}{4}$; $\frac{5}{6}$; $\frac{4}{11}$; $\frac{14}{17}$; $4\frac{1}{3}$; $2\frac{2}{7}$; $3\frac{2}{3}$; $\frac{1}{13}$.

PROBLEM V.

1. $\frac{21}{24}$, $\frac{20}{24}$.
2. $\frac{6}{12}$, $\frac{4}{12}$, $\frac{9}{12}$.
3. $\frac{300}{360}$, $\frac{315}{360}$, $\frac{320}{360}$, $\frac{324}{360}$.
4. $\frac{18}{24}$, $\frac{15}{24}$, $\frac{14}{24}$, $\frac{4}{24}$.
5. $\frac{12}{42}$, $\frac{27}{42}$, $\frac{34}{42}$, $\frac{6}{42}$.
6. $\frac{30}{36}$, $\frac{21}{36}$, $\frac{10}{36}$, $\frac{7}{36}$.
7. $\frac{96}{144}$, $\frac{108}{144}$, $\frac{120}{144}$, $\frac{64}{144}$, $\frac{135}{144}$.
8. $\frac{819}{1287}$, $\frac{1144}{1287}$, $\frac{594}{1287}$.
9. $\frac{2288}{8580}$, $\frac{7865}{8580}$, $\frac{1980}{8580}$, $\frac{780}{8580}$.
10. $\frac{176}{198}$, $\frac{54}{198}$, $\frac{77}{198}$, $\frac{81}{198}$.
11. $\frac{1428}{1785}$, $\frac{765}{1785}$, $\frac{1547}{1785}$, $\frac{1680}{1785}$.
12. $\frac{42}{84}$, $\frac{28}{84}$, $\frac{21}{84}$, $\frac{63}{84}$, $\frac{60}{84}$.
13. $\frac{135}{360}$, $\frac{200}{360}$, $\frac{54}{360}$.
14. $\frac{45782}{15960}$, $\frac{27645}{15960}$, $\frac{11340}{15960}$.

PROBLEM VI.

The Answers are placed opposite the Questions; while the Answers to those in the Note are the Questions in Prob. VII., and *vice versa*.

25. $\frac{3}{7}$ | 26. $\frac{47}{60}$ | 27. $\frac{9}{16}$

PROBLEM VII.

The Answers are the Questions to the Note in Prob. VI.

ADDITION OF VULGAR FRACTIONS.

1. $2\frac{3}{8}$
2. $1\frac{8}{11}$
3. $1\frac{11}{45}$
4. $2\frac{641}{14467}$
5. $\frac{391}{440}$
6. $1\frac{317}{504}$
7. $2\frac{1301}{2160}$
8. $1\frac{247}{374}$
9. $1\frac{517}{2225}$
10. $1\frac{211}{330}$
11. $20\frac{19}{30}$
12. $34\frac{7}{12}$
13. $73\frac{61}{264}$
14. 8s. $2\frac{1}{2}$d. $\frac{1}{11}$
15. £1, 11s. 3d.
16. 3 oz. 3 dwt. $10\frac{34}{35}$ gr.
17. £1, 1s. $4\frac{3}{4}$d. $\frac{3}{5}$
18. £1, 16s. $7\frac{3}{4}$d. $\frac{3}{7}$
19. 1 yd. 3 qr. 2 nl.
20. £1, 13s. $4\frac{1}{35}$d.
21. 13 cwt. 11 lb. $8\frac{8}{15}$ oz.
22. 5 bu. 2 pk. $0\frac{14}{15}$ gal.
23. 4 da. 10 ho. 36 min.
24. £103, 6s. $7\frac{19}{616}$d.
25. 4 cwt. 3 qr. 12 lb. $10\frac{17}{28}$ oz.
26. 112 yd. 2 qr. 2 nl.
27. $\frac{89}{120}$ in 1 day

SUBTRACTION OF VULGAR FRACTIONS.

1. $\frac{23}{60}$
2. $\frac{59}{144}$
3. $\frac{239}{374}$
4. $\frac{901}{1225}$
5. $\frac{173}{1512}$
6. $\frac{73}{143}$
7. $1\frac{3}{8}$
8. $3\frac{11}{12}$
9. $4\frac{1}{4}$
10. $14\frac{4}{7}$
11. $12\frac{5}{8}$
12. $9\frac{17}{56}$
13. 12s. $1\frac{1}{2}$d. $\frac{10}{11}$
14. 14s. $5\frac{1}{2}$d. $\frac{6}{7}$
15. 4s. $4\frac{3}{4}$d. $\frac{29}{33}$
16. 12s.
17. 2 qr. 2 lb.
18. 5 fu. 32 p. 2 yd. $1\frac{1}{2}$ ft.
19. £2, 3s. $5\frac{1}{2}$d. $\frac{10}{11}$
20. $\frac{27}{152}$
21. 5 yd. 3 qr. 2 n.
22. $\frac{39}{70}$
23. $\frac{45}{112}$ gal.

MULTIPLICATION OF VULGAR FRACTIONS.

1. $\frac{11}{15}$
2. $\frac{16}{351}$
3. $\frac{216}{1591}$
4. $\frac{56}{165}$
5. $\frac{315}{968}$
6. $5\frac{5}{7}$
7. $3\frac{31}{48}$
8. $2\frac{9}{13}$
9. 12
10. $60\frac{15}{32}$
11. $213\frac{45}{64}$
12. $17\frac{25}{48}$
13. $17\frac{187}{189}$
14. $244\frac{13}{490}$
15. 11s. $9\frac{1}{2}$d. $\frac{3}{5}$
16. 19s. $5\frac{3}{4}$d. $\frac{5}{77}$
17. £6, 7s. $0\frac{1}{4}$d. $\frac{6}{11}$
18. £1, 1s. $3\frac{1}{4}$d.
19. 4s. $3\frac{3}{4}$d. $\frac{1}{7}$
20. £12, 4s. $3\frac{3}{4}$d. $\frac{19}{35}$

DIVISION OF VULGAR FRACTIONS.

1. $\frac{4}{5}$
2. $\frac{4}{15}$
3. $\frac{12}{37}$
4. $\frac{7}{11}$
5. $\frac{35}{88}$
6. 8
7. $8\frac{3}{4}$
8. 7
9. 16
10. $5\frac{3}{8}$
11. $18\frac{3}{16}$
12. $3\frac{5}{8}$
13. $1\frac{1297}{1439}$
14. $1\frac{10991}{13750}$

15. 5s. $0\frac{1}{4}$d. $\frac{8}{9}$
16. 16s. $3\frac{3}{4}$d. $\frac{83}{195}$
17. 13s. $4\frac{1}{2}$d. $\frac{6}{7}$
18. $\frac{16}{121}$
19. 1926 $\frac{468}{667}$
20. £45, 15s. $3\frac{7}{55}$d.
£23, 9s. $2\frac{1}{4}$d. $\frac{339}{341}$

EXERCISES IN VULGAR FRACTIONS.

1. $11\frac{1}{1}$; $22\frac{2}{2}$; $33\frac{3}{3}$; $44\frac{4}{4}$
2. $9\frac{2}{9}$; $99\frac{8}{9}$; $999\frac{9}{9}$
3. £27, 10s. $10\frac{3}{4}$d. $\frac{43}{72}$
4. $\frac{157}{420}$ remained
5. $15\frac{13}{18}$ gal.
6. $2\frac{4}{11}$ pk.; $\frac{47}{70}$ pt.
7. $122\frac{1116}{2048}$ lb.
8. £1, 0s. $4\frac{1}{2}$d. $\frac{49}{60}$
9. £2100
10. £75, 11s. $1\frac{1}{203}$d.
11. £16, 16s. a man's sh.
£5, 12s. a woman's sh.
12. £990, value of mine
13. 209, the number
14. 1570, the number
15. $\frac{5}{24}$ of 10 guineas
16. 31 years
17. $\frac{37}{60}$ in 1 day
18. A. $\frac{1}{6}$; B. $\frac{2}{15}$
19. 3cwt.3qr.24lb. a m.'s sh.
1 cwt.1qr. 8lb. a w.'s sh.
1 qr. 9 lb. a child's sh.
20. $1\frac{1289}{2088}$
21. £16632, value of estate
22. $\frac{7}{27}$; val. £1166, 13s. 4d.
23. $144\frac{49}{243}$ yards
24. 12s. per £1
25. $94\frac{2}{25}$, the number
26. $149\frac{4}{107}$ coins
27. $\frac{2736}{4375}$ lb. avoir.
28. 16s. $7\frac{1}{2}$d. $\frac{14}{15}$
29. £24,5s.$11\frac{3}{4}$d. a man's sh.
£18,4s.$5\frac{3}{4}$d.$\frac{1}{4}$, a wo.'s sh.
£14,11s.$7\frac{1}{20}$d. a ch.'s sh.
30. $7\frac{1}{2}$ ho.; 200 miles
31. 75, 40, and 36
32. 240 men

SIMPLE PROPORTION.

1. 18s. for 24 yds.
2. 3s. for 4 yds.
3. 24 yds. for 18s.
4. 4 yds. for 3s.
5. £10, 11s. 6d.
6. 10 4 0
7. 8 15 0
8. 76 15 0
9. 7 8 6
10. 2 0 1
11. 1 17 $0\frac{1}{2}$
12. £14, 16s. 3d.
13. 88 5 0
14. 85 18 $5\frac{1}{4}$
15. 147 5 0
16. 231 2 $0\frac{3}{4}$
17. 828 14 3
18. $14\frac{1}{21}$ lb.
19. 2 cwt. 1 qr.
20. 1 cwt. $20\frac{76}{351}$ lb.
21. £7, 8s. $9\frac{3}{4}$d. $\frac{1}{5}$
22. 22 0 $11\frac{3}{4}$ $\frac{11}{17}$

23. £4, 3s. $1\frac{1}{2}$d.
24. 3 17 $9\frac{1}{2}$ $\frac{6}{7}$
25. 175 12 $10\frac{3}{4}$ $\frac{40}{47}$
26. 2 2 $4\frac{3}{4}$ $\frac{1}{3}$
27. 272 1 $0\frac{1}{2}$
28. 242 19 $10\frac{1}{2}$ $\frac{20}{27}$
29. 5565 12 $10\frac{1}{4}$ $\frac{3}{4}$
30. 176 4 $10\frac{1}{2}$ $\frac{119}{144}$
31. $380\frac{1}{4}$ yd.
32. 2s. $9\frac{1}{2}$d. $\frac{2}{3}$
33. 2571 pairs
34. £7, 13s. 0d.
35. 89 11 $6\frac{3}{4}$
36. 48 6 $5\frac{1}{7}$
37. 17 12 $4\frac{1}{2}$ $\frac{6}{11}$
38. 821 9 $10\frac{1}{2}$
39. 7 6 8
40. 3160 8 3
41. 63 da.
42. 8 men
43. $240\frac{12}{37}$ da.
44. 112 persons
45. 4 lb. 10 oz. $10\frac{2}{3}$ dr.
46. 5s., price of wheat
47. $158\frac{19}{25}$ gal. rum
$6225\frac{16}{17}$ lb. sugar
48. 539 yds. at $50\frac{3}{4}$d. $\frac{3}{7}$
49. $2844\frac{12}{59}$ lb. of each
50. 1500 men
51. 1 mo. 1 wk. 1 da.
52. £9, 18s. 0d.
53. 5 3 0 per lb.
54. 126 13 $1\frac{1}{2}$
55. 4 lb. 1 oz. $4\frac{18}{25}$ dr.
56. £1, 17s. 6d.
57. 2s. $2\frac{3}{4}$d. $\frac{71}{75}$
58. Neither
59. $363\frac{6}{13}$ lb. flax
$1453\frac{11}{13}$ lb. hemp
60. £2689, 17s.
61. 2700 men
62. £735
63. 400 men
64. 30 yards
65. £59, 10s.
66. 10s. 6d. per £
67. 13 oz. $5\frac{1}{3}$ dr.
68. 9 mo. 18 da.
69. £87, 10s. 0d.
70. 6 8 $5\frac{1}{4}$ $\frac{3}{5}$
71. 26 0 0
72. 0 10 $2\frac{1}{4}$ $\frac{3}{5}$
73. 9 7 6
74. 4 15 0
75. $47\frac{164}{187}$ stones butter
$111\frac{160}{187}$ stones wool
76. $37\frac{6}{7}$ doz. and 17s. $8\frac{1}{7}$d,
77. £1285, 10s.
78. £166, 13s. 4d.
79. 2 ho. 6 min.
80. 208 qrs.
81. 70 loaves
82. £12 per acre
83. 256 gall.
84. $32\frac{8}{11}$ min. past 6
85. £26, 2s. 6d.
86. 56 yd. 2 qr. $3\frac{1}{5}$ nl.
87. 51 yards
88. 282 cwt. 2 qr.
89. 1s. 4d. per yd.
90. $34\frac{2}{7}$ miles
91. 3s. rate per yd.
92. 504 yd.
93. $1193\frac{17}{231}$ cwt. sugar
$11248\frac{48}{49}$ gal. rum
94. 150 yds.
95. 140 yds.
96. 25920 yds.
97. £40, 3s. 3d.
98. 3 1 $6\frac{3}{4}$ $\frac{5}{9}$
99. 2 14 $3\frac{1}{4}$ $\frac{6}{7}$
100. 0 2 $5\frac{1}{2}$ $\frac{6}{13}$

101. £8, 5s. 0d.	109. £400, 14s. 3¼d. $\frac{6}{7}$
102. 6 16 8½ ½	110. 13 mo. 19$\frac{2909}{4084}$ da.
103. 1 9 7	111. 6$\frac{42}{53}$ da.
104. 260 11 1¼ ⅓	112. £5, 12s. 6d.
105. 322 0 0	113. 3 3 0
106. 1 17 1¼ $\frac{67}{169}$	114. 0 6 10¾ ⅕
107. 56 yd. 3$\frac{17}{125}$ nl.	115. 100 goats, 400 sheep
108. 200 ft. 5$\frac{6}{11}$ in.	116. 2$\frac{113}{175}$ ho.

117. 25$\frac{28}{57}$ da.

COMPOUND PROPORTION.

1. 15 weeks, 3⅓ days	14. 4½ years
2. 125 reams	15. 206$\frac{6}{59}$ qrs.
3. 30 lb. wool	16. 1350 miles
4. £288, 15s.	17. 43⅕ days
5. £40, 10s.	18. 26⅔ miles
6. 425 ro. 32⅘ yd.	19. 5s. 11⅓d.
7. 65 ac. 3 ro. 12$\frac{4}{7}$ per.	20. 36 in.
8. £5, per cent.	21. £15
9. £15, 8s. 0¾d. $\frac{69}{73}$	22. 21⅓ days
10. £13, 6s. 9¾d. $\frac{9}{13}$	23. 100 ft.
11. £4, 10s. per cent.	24. £2, 10s. 10¼d. $\frac{11}{13}$
12. £3, 10s.	25. 19$\frac{29}{175}$ yards
13. £470 principal	26. 12 oz. 3$\frac{27}{55}$ dr.

27. 37½ days

PRACTICE.

CASE I.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	1979	0	0	7.	740	15	0	13.	1554	15	9
2.	1789	0	0	8.	697	18	4	14.	827	11	6
3.	738	12	0	9.	499	17	4	15.	712	19	0
4.	4687	0	0	10.	495	7	6	16.	1117	8	8
5.	2846	6	8	11.	2586	13	6	17.	591	8	3
6.	1247	0	0	12.	2622	11	0	18.	620	12	6

	£	s.	d.		£	s.	d.		£	s.	d.
19.	185	14	0	27.	9	16	4½	35.	1181	12	6
20.	82	3	4	28.	1714	16	0	36.	103	4	3
21.	71	11	6	29.	113	6	0	37.	1264	6	8
22.	74	12	10	30.	2464	0	0	38.	79	16	0
23.	62	8	6	31.	789	16	8	39.	749	6	0
24.	20	5	2	32.	35	17	4½	40.	27	19	9
25.	23	10	6	33.	592	13	9	41.	4469	0	0
26.	14	3	1½	34.	11	18	8	42.	631	17	4

CASE II.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	7	16	0½	21.	35	19	2½	41.	220	0	4½
2.	3	0	8¾	22.	34	10	3	42.	525	4	0
3.	5	10	6½	23.	47	7	10	43.	744	3	0
4.	1	16	9	24.	29	17	11	44.	146	13	6¾
5.	11	5	3¼	25.	32	6	9	45.	380	16	4½
6.	7	13	6¾	26.	16	5	6	46.	549	2	10¼
7.	13	19	5	27.	57	4	0	47.	549	5	7½
8.	10	10	3¾	28.	149	1	3	48.	2821	10	0
9.	16	19	3½	29.	151	13	0	49.	2856	16	3
10.	14	0	6	30.	192	19	4	50.	6594	3	6
11.	18	10	10¾	31.	163	8	9	51.	2358	13	6
12.	18	14	11¼	32.	355	2	6	52.	3255	7	0
13.	13	8	7	33.	103	6	8	53.	1163	15	0
14.	17	18	5	34.	278	16	8	54.	1679	17	4
15.	24	2	3½	35.	360	0	0	55.	3397	6	8
16.	13	17	4	36.	631	6	8	56.	859	14	8
17.	18	4	6	37.	705	16	8	57.	4520	5	4
18.	29	18	1½	38.	111	4	0	58.	11382	16	0
19.	23	8	10½	39.	324	0	0	59.	15452	8	0
20.	29	7	5	40.	225	12	6	60.	9278	15	6

CASE III.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	34	16	0	6.	1432	12	0	11.	705	17	0
2.	287	2	0	7.	2303	2	0	12.	911	5	0
3.	233	4	0	8.	341	12	0	13.	1087	4	0
4.	682	10	0	9.	405	12	0	14.	1904	0	0
5.	753	10	0	10.	812	12	0	15.	1552	18	0

	£	s.	d.		£	s.	d.		£	s.	d.
16.	3757	1	0	21.	596	18	4	26.	200	11	6
17.	1065	12	0	22.	785	4	0	27.	888	5	8
18.	3639	15	0	23.	238	3	3	28.	2818	9	4
19.	1779	18	0	24.	52	13	6	29.	2028	11	1
20.	495	1	6	25.	357	16	6	30.	1338	8	0

CASE IV.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	961	4	2	5.	3041	1	$7\frac{1}{2}$	9.	739	10	11
2.	9168	2	8	6.	401	7	9	10.	634	7	6
3.	661	12	11	7.	3808	16	$3\frac{1}{2}$	11.	701	7	$3\frac{3}{4}\ \frac{1}{3}$
4.	2548	3	0	8.	8077	19	4	12.	1162	9	$8\frac{1}{2}\ \frac{2}{3}$

CASE V.

	£	s.	d.		£	s.	d.
1.	73	14	$8\frac{0}{4}\ \frac{4}{7}$	19.	76	13	$8\frac{3}{4}\ \frac{231}{240}$
2.	101	6	7	20.	19	2	$8\frac{0}{4}\ \frac{1}{3}$
3.	43	6	$6\frac{0}{4}\ \frac{3}{7}$	21.	223	7	$7\frac{1}{2}\ \frac{2}{5}$
4.	72	19	$9\frac{1}{2}\ \frac{11}{14}$	22.	414	6	0
5.	19	8	$9\frac{3}{4}\ \frac{3}{4}$	23.	196	14	$9\frac{1}{2}\ \frac{3}{5}$
6.	6	18	$9\frac{0}{4}\ \frac{23}{28}$	24.	160	10	2
7.	281	19	$1\frac{1}{4}\ \frac{6}{7}$	25.	219	15	$6\frac{1}{4}\ \frac{7}{60}$
8.	164	4	4	26.	235	6	$10\frac{1}{4}\ \frac{1}{6}$
9.	38	14	$1\frac{1}{2}$	27.	1216	15	$4\frac{0}{4}\ \frac{4}{5}$
10.	3633	13	$9\frac{1}{4}\ \frac{1}{2}$	28.	379	7	$0\frac{1}{4}\ \frac{1}{5}$
11.	1	0	$9\frac{1}{4}\ \frac{5}{7}$	29.	12	3	$6\frac{1}{2}\ \frac{1}{2}$
12.	0	9	11	30.	15	4	$5\frac{1}{4}\ \frac{3}{10}$
13.	160	5	10	31.	142	8	$2\frac{3}{4}\ \frac{5}{6}$
14.	2420	10	$8\frac{1}{2}\ \frac{3}{7}$	32.	36	6	3
15.	14	18	$1\frac{3}{4}\ \frac{6}{7}$	33.	104	14	9
16.	121	6	$2\frac{1}{4}\ \frac{19}{28}$	34.	46	13	$9\frac{3}{4}$
17.	19	19	$2\frac{1}{2}\ \frac{1}{2}$	35.	732	5	10
18.	7	12	$5\frac{1}{2}\ \frac{7}{8}$				

EXERCISES UNDER THE NOTES.

	£	s.		£	s.		£
1.	79	16	4.	88	16	7.	1032
2.	126	8	5.	17	2	8.	11760
3.	75	4	6.	348	0	9.	131520

	£	s.	d.		£	s.	d.		£	s.	d.
10.	3	5	4	13.	2	13	8	16.	40	12	0
11.	4	8	8	14.	5	19	0	17.	70	11	8
12.	5	5	0	15.	31	17	0	18.	57	8	0

19. £75, 2s. 8d.

PROMISCUOUS EXERCISES.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	375	19	1	9.	638	3	$10\frac{1}{2}$	16.	18	0	$6\frac{3}{4}$ $\frac{1}{2}$
2.	38588	4	0	10.	304	1	$11\frac{3}{4}$	17.	1943	3	$2\frac{1}{4}$ $\frac{3}{7}$
3.	8310	4	7	11.	5327	7	0	18.	126	8	$7\frac{0}{4}$ $\frac{6}{7}$
4.	843	·10	0	12.	7107	9	$3\frac{1}{2}$	19.	18	6	$1\frac{3}{4}$
5.	7174	17	8	13.	2448	15	0	20.	415	15	$0\frac{3}{4}$ $\frac{9}{10}$
6.	38664	0	$2\frac{1}{2}$	14.	16	6	$9\frac{1}{4}$ $\frac{1}{3}$	21.	2668	18	$9\frac{3}{4}$
7.	26624	2	6	15.	187403 lb.	10 oz.		22.	3612	11	$2\frac{0}{4}$ $\frac{3}{5}$
8.	4244	8	0		18 dwt.			23.	4333	14	$4\frac{0}{4}$ $\frac{1}{3}$

24. £4961, 19s. 7d.

BILLS OF PARCELS.

	£	s.	d.		£	s.	d.		£	s.	d.
1.	52	9	$4\frac{1}{2}$	6.	360	15	2	11.	1707	16	5
2.	16	13	1	7.	462	13	$3\frac{1}{4}$	12.	965	19	$11\frac{3}{4}$ $\frac{6}{7}$
3.	65	2	10	8.	986	7	$6\frac{1}{2}$	13.	1988	9	$3\frac{3}{4}$ $\frac{4}{7}$
4.	88	11	$9\frac{0}{4}$ $\frac{1}{4}$	9.	329	15	$4\frac{3}{4}$ $\frac{3}{4}$	14.	1822	9	$1\frac{1}{4}$ $\frac{29}{42}$
5.	246	0	0	10.	1961	12	$9\frac{1}{2}$				

DECIMAL FRACTIONS.

ADDITION AND SUBTRACTION OF FINITE DECIMALS.

1.	6637·872625	3.	966·609554	5.	105·2592494
2.	2282·30009	4.	246·0884	6.	2468·92795

7. 35·77; 80·438504; 2·18693; ·2978; ·215846; 3·627; ·000691; 74·9943; 62·5175

MULTIPLICATION OF FINITE DECIMALS.

1.	50387·0389	7.	6·19014	12.	641·52 913·275
2.	59728·5838	8.	·633654	13.	781·4 7814
3.	·0646263	9.	·000312	14.	9851·6
4.	·0009282	10.	18·164	15.	6871460
5.	2·7321	11.	448·8 5·61		
6.	17·586				

DIVISION OF FINITE DECIMALS.

1. 13·31
·75625
2. ·61436
7·87532725
3. 79·347
73475·322
4. 416·1857
5. 3·157947
6. ·003596
7. 3138758
8. $116648\cdot1\dot{6}$
9. $111\cdot359\frac{7}{137}$
10. $1105\cdot363545\frac{26}{677}$
11. $22\cdot9299363\frac{9}{137}$
40000
12. 7·48635
13. 165·186

REDUCTION OF FINITE DECIMALS.

PROBLEM I.

1. ·625
2. ·5
3. ·25
4. ·75
5. ·875
6. $\cdot\dot{3}$
7. $\cdot\dot{1}$
8. $\cdot8\dot{3}$
9. $\cdot1\dot{6}$
10. ·5625
11. ·2
12. $\cdot01\dot{3}$
13. $\cdot0005\dot{3}$
14. $\cdot\dot{6}\dot{3}$
15. $\cdot\dot{7}\dot{2}$
16. $\cdot\dot{4}$
17. $\cdot\dot{8}\dot{1}$
18. $\cdot\dot{1}4285\dot{7}$
19. $\cdot\dot{2}\dot{7}$
20. $\cdot\dot{0}7692\dot{3}$
21. $\cdot\dot{0}\dot{1}$
22. $\cdot2\dot{0}3\dot{7}$
23. $\cdot\dot{6}$
24. $\cdot\dot{9}41176470588235\dot{2}$

PROBLEM II.

1. $\frac{1}{2}$
2. $\frac{1}{4}$
3. $\frac{3}{4}$
4. $\frac{1}{8}$
5. $\frac{5}{8}$
6. $\frac{17}{50}$
7. $\frac{3}{8}$
8. $\frac{1}{200}$
9. $\frac{29}{500}$
10. $\frac{4}{25}$
11. $\frac{1}{32}$
12. $\frac{3}{160}$
13. $3\frac{6}{25}$
14. $5\frac{16}{125}$
15. $7\frac{64}{125}$
16. $6\frac{3}{40}$
17. $\frac{21}{4000}$
18. $\frac{1}{64}$
19. $\frac{5}{64}$
20. $\frac{249}{40000}$

PROBLEM III.

1. £·0375
2. $\cdot041\dot{6}$
3. ·875
4. ·634375
5. $\cdot998958\dot{3}$
6. $\cdot71458\dot{3}$
7. $£\cdot1\dot{6}$
8. $\cdot\dot{3}$
9. $\cdot\dot{6}$
10. $\cdot0458\dot{3}$
11. ·01875
12. ·003125
13. ·0625 cwt.
14. $\cdot\dot{0}71428\dot{5}$ cwt.
15. $\cdot007589\frac{2}{7}$ ton
16. $\cdot905803\frac{4}{7}$ ton
17. ·9875 lb. tr.
18. $\cdot0569\dot{4}$ lb. tr.
19. ·275 oz. tr.
20. ·00439453125 cwt.
21. ·671875 lb. av.
22. $\cdot3097\dot{2}$ lb. tr.
23. ·75 yard
24. ·375 yard
25. ·765625 mile
26. ·56875 acre

27. $\cdot\dot{8}$ foot
28. $\cdot 91\dot{6}$ sh.
29. $\cdot 8\dot{3}$ sh.
30. ·625 sh.
31. $\cdot 5902\dot{7}$ gu.
32. ·61328125 qr.
33. $1\cdot 0\dot{8}\dot{5}$ pole
34. $\cdot 019863\frac{1}{73}$ year
35. $\cdot 29791\dot{6}$ day
36. ·3675 hour
37. ·3875 acre
38. $\cdot 12665289\frac{31}{121}$ acre
39. $\cdot 01524334\frac{274}{1089}$ rood
40. $\cdot 009589\frac{3}{73}$ year

PROBLEM IV.

1. 0s. 9d.
2. 0 $9\frac{3}{4}$ $\frac{117}{125}$
3. 17 6
4. 12 $8\frac{1}{4}$
5. 19 $11\frac{1}{2}$ $\frac{31249}{31250}$
6. 14s. $3\frac{1}{2}$d.
7. 3 $2\frac{1}{4}$ $\frac{3}{5}$
8. 6 0
9. 12 0
10. 0 $10\frac{3}{4}$ $\frac{623}{625}$
11. 0s. $4\frac{1}{2}$d.
12. 0 $0\frac{3}{4}$
13. 7 lb.
14. $7\frac{15624}{15625}$ lb.
15. $16\frac{3123}{3125}$ lb.
16. 18 cwt. 12 lb. $15\frac{109}{125}$ oz.
17. 11 oz. 17 dwt.
18. 13 dwt. $15\frac{609}{625}$ gr.
19. 5 dwt. 12 gr.
20. 7 oz. $13\frac{15387}{15625}$ dr.
21. 10 oz. 12 dr.
22. 3 oz. 14 dwt. $7\frac{617}{625}$ gr.
23. 3 qr.
24. 1 qr. 2 nl.
25. 6 fur. 5 po.
26. 2 ro. 11 per.
27. $9\frac{3}{8}$ in.
28. 0s. $10\frac{3}{4}$d. $\frac{121}{125}$
29. 0 $9\frac{3}{4}$ $\frac{21}{25}$
30. 0 $7\frac{1}{2}$
31. 12 $4\frac{1}{2}$ $\frac{6201}{6250}$
32. 4 bu. 3 pk. $1\frac{1}{4}$ gal.
33. 5 yd. 2 ft. 10·83 in.
34. 7 da. 5·99988 ho.
35. 7 ho. 8 min. $58\frac{14}{25}$ sec.
36. 22 min. 3 sec.

CONTRACTIONS IN DECIMALS.

CONTRACTION 1.

1. ·3278
2. 3·701
3. 3·1408
4. 33·53650
5. ·520958
6. ·373052

CONTRACTION 2.

1. 2·3487
2. 1·8770
3. 10·235
4. 23·1092
5. 0·15681
6. 1868·740

CONTRACTION 3.

1. £·43541$\dot{6}$
2. ·367708$\dot{3}$
3. ·478125
4. ·734375
5. £·67291$\dot{6}$
6. ·890625
7. 4·525
8. 3·4291$\dot{6}$
9. £4·33541$\dot{6}$
10. 7·786458$\dot{3}$
11. 2·65625
12. 3·834375

CONTRACTION 4.

1. 8s. 11¾d.
2. 6 6
3. 50 8¾
4. 13 6¾
5. 18 1
6. £0, 16s. 4¼d.
7. 4 19 7½
8. 6 14 10½
9. 4 19 11¾
10. 0 15 11¾
11. £0, 17s. 4¼d.
12. 0 17 5¾
13. 4 16 6
14. 6 19 6¾
15. 9 9 4½

EXERCISES IN FINITE DECIMALS.

1. £97, 0s. 7½d.
2. 286 cwt. 3 qr. 8⅗ lb.
3. ·2 pint
4. ·46875
5. ·525
6. £8, 18s. 4½d. $\frac{18}{71}$ a man
   3 6 10½ $\frac{60}{71}$ a boy
7. £19, 11s. 1⅓d. gain
8. 89 16 1$\frac{5}{64}$ int.
9. 9 11 6¾ $\frac{3}{7}$ value
10. 121 poor
11. ·0000050475
    5319277$\frac{9}{53}$
12. ·525
13. 9s. 1⅕d.

INTERMINATE DECIMALS.

REDUCTION OF INTERMINATE DECIMALS.

PROBLEM I.

$\frac{7}{9}$; $\frac{1}{3}$; $\frac{2}{3}$; $\frac{3}{11}$; $\frac{6}{11}$; $\frac{7}{111}$; $\frac{5}{27}$; $\frac{2}{27}$; $\frac{26}{27}$; $\frac{3}{7}$; $\frac{9}{1111}$
$\frac{8}{13}$; $\frac{2}{21}$; $\frac{4}{7}$; $\frac{27}{37}$; $\frac{124}{333}$; $\frac{25}{111}$

PROBLEM II.

$\frac{7}{12}$; $\frac{13}{44}$; $\frac{1}{6}$; $\frac{1}{22}$; $\frac{1763}{2700}$; $\frac{1}{150}$; $\frac{1179}{1850}$; $\frac{338}{23725}$; $\frac{5}{6}$; $\frac{3}{20}$; $\frac{3199}{5550}$;
$\frac{16}{2775}$; $\frac{1198}{12825}$; $\frac{7}{27000}$; $\frac{25}{74}$

PROBLEM III.

1. $\cdot\dot{3}6363\dot{6}$
   $\cdot\dot{4}6846\dot{8}$
2. $\cdot 0\dot{4}24\dot{2}$
   $\cdot 1\dot{4}59\dot{1}$
3. $\cdot 00\dot{7}6767\dot{6}$
   $\cdot 13\dot{7}1371\dot{3}$
4. $\cdot 333\dot{3}3333\dot{3}$
   $\cdot 264\dot{1}8181\dot{8}$
   $\cdot 405\dot{4}0540\dot{5}$
5. $\cdot 485\dot{4}5454\dot{5}$
   $\cdot 762\dot{9}2792\dot{7}$
6. $\cdot 1\dot{5}3653\dot{6}$
   $\cdot 0\dot{7}7777\dot{7}$
   $\cdot 0\dot{0}2020\dot{2}$
7. $1\cdot 424\dot{2}4242\dot{4}$
   $\cdot 000\dot{7}7777\dot{7}$
   $\cdot 145\dot{9}2592\dot{5}$
8. $\cdot 00\dot{4}44444444444\dot{4}$
   $\cdot 24\dot{5}92459245924\dot{4}$
   $\cdot 16\dot{8}76876876876\dot{6}$
9. $\cdot 1\dot{2}9129129129\dot{1}$
   $\cdot 0\dot{4}0104010401\dot{0}$
   $1\cdot 0\dot{3}3333333333\dot{3}$

ADDITION AND SUBTRACTION OF INTERMINATE DECIMALS.

CASE I.

1. $8\cdot 224\dot{3}$
2. $6\cdot 62\dot{8}$
3. $8\cdot 528\dot{3}$
4. $2\cdot 2724\dot{6}$
5. $74\cdot 375$
6. $52\cdot 3075$
7. £$28\cdot 59791\dot{6}$
8. $\cdot 08020\dot{7}$
9. $\cdot 191\dot{6}$
10. $11\cdot 885\dot{7}$
11. $4\cdot 7\dot{1}$
12. $8\cdot 58\dot{3}$
13. $20\cdot 065\dot{1}$
14. $\cdot 969791\dot{6}$
15. £$1\cdot\dot{6}$
16. $13\cdot 582291\dot{6}$
17. $8\cdot 625$ days.

CASE II.

1. $1\cdot 903\dot{1}5467312497\dot{0}$
2. $2\cdot 04\dot{8}0786727321\dot{3}$
3. $2\cdot\dot{4}6198\dot{1}$
4. $\cdot 67\dot{3}7089\dot{0}$
5. $8\cdot 412\dot{8}05\dot{2}$
6. $3\cdot 40\dot{5}1282\dot{0}$
7. $48\cdot 1\dot{2}\dot{7}$ ml.
8. $\cdot 46\dot{4}2857\dot{1}$
9. $\cdot 009\dot{0}3108\dot{0}$
10. $\cdot 2\dot{6}1904\dot{7}$
11. $13\cdot 72\dot{6}1904\dot{7}$
12. $4\cdot\dot{2}0512\dot{8}$
13. $6\cdot\dot{0}8\dot{2}$

MULTIPLICATION OF INTERMINATE DECIMALS.

1. $1{\cdot}1\dot{6}$
2. $243{\cdot}75$
3. $21{\cdot}14\dot{6}$
4. $243{\cdot}9791\dot{6}$
5. $3983{\cdot}\dot{3}$
6. $678222{\cdot}\dot{2}$
7. $3{\cdot}\dot{3}7\dot{0}$
8. ${\cdot}37\dot{5}9\dot{2}$
9. $14{\cdot}\dot{5}\dot{4}$
10. $2614{\cdot}2\dot{8}5714\dot{2}$
11. $5083{\cdot}7645\dot{2}7\dot{0}$
12. ${\cdot}24553\dot{5}7142\dot{8}$
13. ${\cdot}208\dot{3}$
14. $6{\cdot}\dot{7}83950617\dot{2}$
15. ${\cdot}413\dot{1}$
16. $233{\cdot}877\dot{1}$
17. ${\cdot}041\dot{5}$
18. ${\cdot}144\dot{2}\dot{4}$
19. ${\cdot}3$
20. $49{\cdot}725$
21. $9{\cdot}2507318$
22. ${\cdot}3\dot{9}3611\dot{7}$
23. ${\cdot}2049\dot{6}\dot{0}$
24. $6{\cdot}026\frac{2}{243}$
25. $25{\cdot}3541\dot{6}$
26. $4{\cdot}9\dot{0}2948\dot{4}$
27. $2{\cdot}\dot{1}9373\dot{2}$
28. $24{\cdot}\dot{7}8\dot{8}$
29. $5{\cdot}3\dot{8}$
30. ${\cdot}2\dot{6}\dot{0}$

DIVISION OF INTERMINATE DECIMALS.

1. $1{\cdot}291\dot{6}$
2. ${\cdot}\dot{4}8\dot{1}$
3. ${\cdot}1134\dot{2}$
4. $11{\cdot}74\dot{6}$
5. $10{\cdot}0\dot{4}$
6. $3386{\cdot}\dot{6}$
7. $150{\cdot}5\dot{3}$
8. ${\cdot}1458$
9. $52{\cdot}875$
10. $26{\cdot}\dot{8}$
11. $7{\cdot}52\frac{40}{261}$
12. $19{\cdot}8$
13. ${\cdot}0065448\frac{9}{32}$
14. $20{\cdot}\dot{5}7142\dot{8}$
15. ${\cdot}52\dot{1}1\dot{7}$
16. ${\cdot}83818125$
17. ${\cdot}1069\dot{4}$
18. ${\cdot}\dot{6}09\dot{0}$

EXERCISES IN DECIMAL FRACTIONS.

1. 9·3 lb.
2. ·15 or $\frac{3}{20}$ vessel
3. £3, 5s. 8¼d. $\frac{1}{5}$
4. 2 13 6¾ $\frac{11}{84}$
5. 0 17 1¼ $\frac{3361}{8619}$
6. 0 2 7¼ $\frac{6}{7}$
7. 0 17 8
   0 2 10$\frac{3}{25}$
   1 qr. 13 lb. 11 oz. 9$\frac{1037}{1125}$dr.
   5 fu. 15 po. 4 yd. 4$\frac{18}{35}$ in.
   12s. 3d.
8. 14s. 1¾d. $\frac{269}{375}$
   1 qr. $19{\cdot}0\dot{0}0\dot{2}$ lb.
   15s. 0½d. $\frac{1583}{1665}$
   3 ro. 15 per. 16$\frac{389}{404}$ yd.
9. 4s. 9¾d. $\frac{1}{7}$
10. 20·982499 $\frac{689}{18099}$ ml.
11. £457, 7s. 7½d. $\frac{5}{7}$
12. £1, 1s. 6$\frac{17}{720}$d.
13. 10 oz. 3 dwt. $7{\cdot}76\dot{2}$ gr.
14. 7925·626 ml.

15. ·0625
16. ·00003861504216000
17. £95·$\dot{3}$
18. £7, 14s. 11½d.
19. 273318·33 ml.
20. £358·9$\frac{3}{7}$ first family
    £465·2$\dot{7}$ second family
21. £77, 17s. 10¼d. $\frac{41}{47}$ man
    £48, 13s. 8$\frac{3}{4}$d. $\frac{8}{47}$ boy
22. £587·65432$\dot{1}$
23. 12 hours
24. £18·70$\dot{5}$
25. 117$\frac{43}{87}$ yd.

ALLOWANCES ON GOODS.

	cwt.	qr.	lb.	
1.	11	3	18	tare
2.	648	3	6	net
3.	1347	3	0	〃
4.	114	3	24	〃
5.	1615	3	14	〃
6.	31	1	10	〃
7.	410	1	3½	〃
8.	270	2	10	〃
9.	832	1	11	〃
10.	618	1	6½	〃
11.	273	2	23⅝	〃
12.	372	0	11⅝	〃
13.	56	3	26$\frac{43}{56}$	〃
14.	284	0	9$\frac{1}{7}$	〃
15.	26	1	0	〃
16.	141	3	0	〃
17.	105	3	4$\frac{4}{7}$	net
18.	136	0	8$\frac{39}{56}$	〃
19.	33	0	8	〃
20.	2	3	16$\frac{12}{13}$	tret
21.	3	2	25$\frac{4}{13}$	〃
22.	5476	2	27$\frac{5}{26}$	〃
23.	93	1	16$\frac{15}{26}$	〃
24.	56	2	25$\frac{2}{91}$	〃

25. 633 gal. 5$\frac{13}{15}$ pt.
26. 304⅕ lb. net
    £958, 4s. 7⅕d. value
27. £79, 15s.
28. 70$\frac{10}{11}$ lb. pure gold
29. 154$\frac{74}{151}$ gross
30. 642$\frac{6}{7}$ bu. malt
31. 263⅝ bu.
32. £2079 present capital

COMMISSION AND BROKERAGE.

	£	s.	d.	
1.	20	15	7¾	⅕
2.	12	0	1¾	$\frac{14}{25}$
3.	13	10	1¼	⅗
4.	1	11	0½	⅖
5.	1	11	10¾	⅕
6.	3	10	3¼	⅕
7.	3	4	2¾	⅗
8.	0	16	10$\frac{3}{4}$	$\frac{31}{50}$
9.	1	10	2¼	$\frac{7}{125}$
10.	1	6	10¾	$\frac{17}{25}$
11.	0	18	6¾	
12.	4	2	0	

	£	s.	d.	
13.	26	14	$9\frac{1}{2}$	$\frac{3}{5}$
14.	15	10	$10\frac{1}{2}$	
15.	86	4	$7\frac{1}{2}$	
16.	33	18	$11\frac{3}{4}$	$\frac{1}{5}$
17.	398	3	0	
18.	75	13	0	
19.	5	6	6	
20.	49	10	0	com.
	1395	15	4	
21.	98	1	$9\frac{3}{4}$	
22.	18	2	$4\frac{3}{4}$	$\frac{3}{5}$
	677	0	$8\frac{3}{4}$	$\frac{3}{5}$

23. £583, 13s. $2\frac{1}{4}$d. $\frac{71}{100}$

INSURANCE.

	£	s.	d.	
1.	2	11	9	
2.	0	9	$4\frac{1}{2}$	
3.	97	10	0	
4.	118	7	6	
5.	0	8	$2\frac{1}{4}$	
6.	4	6	$10\frac{1}{2}$	$\frac{3}{5}$
7.	452	17	3	
8.	272	1	3	
9.	15	13	$4\frac{1}{2}$	
10.	600	0	0	
11.	2400	0	0	
12.	200	0	0	
13.	1200	0	0	
14.	6000	0	0	
15.	8000	0	0	
16.	623	15	$6\frac{1}{2}$	$\frac{34534}{143641}$
17.	1525	10	$5\frac{1}{2}$	$\frac{50618}{52441}$
18.	942	12	$3\frac{3}{4}$	$\frac{397041}{543169}$
19.	828	1	$11\frac{3}{4}$	$\frac{141025}{229441}$
20.	895	10	$7\frac{0}{4}$	$\frac{2234948}{3751969}$
21.	3984	2	$11\frac{0}{4}$	$\frac{968980}{3433609}$

22. Av. loss 5 p. cent.
Owners lose £225
Insurers lose 280
Freighters lose 80

23. Gen. Av. £11, 15s. $5\frac{1}{7}$d. per cent.

23. Par. Av. £37, 10s. per cent.

Own. of sh. lose	£412,	0s.	0d.
〃 〃 cargo	963	11	$5\frac{1}{7}$
Insurers lose	1434	8	$6\frac{6}{7}$

24. £240, 2s. $10\frac{3}{4}$d. $\frac{161}{1021}$*

SIMPLE INTEREST.

	£	s.	d.	
1.	30	3	$9\frac{1}{4}$	$\frac{22}{25}$
2.	307	18	$0\frac{0}{4}$	$\frac{17}{100}$
3.	375	18	$3\frac{1}{4}$	$\frac{13}{20}$
4.	1030	8	$11\frac{1}{2}$	
5.	8	9	$11\frac{1}{4}$	$\frac{111}{200}$
6.	3	8	$0\frac{1}{2}$	$\frac{7}{40}$
7.	4	18	$9\frac{3}{4}$	$\frac{77}{240}$
8.	1	3	$11\frac{1}{2}$	$\frac{63}{100}$
9.	3	0	$3\frac{1}{3}$	$\frac{10}{13}$
10.	13	11	$10\frac{0}{4}$	$\frac{8}{13}$
11.	16	4	$10\frac{1}{4}$	$\frac{7}{25}$
12.	3	1	$7\frac{0}{4}$	$\frac{1772}{1825}$
13.	2	19	$1\frac{0}{4}$	$\frac{33927}{146000}$
14.	7	12	$8\frac{1}{4}$	$\frac{1671}{1825}$
15.	4	18	$7\frac{1}{2}$	$\frac{26}{365}$
16.	20	11	$10\frac{3}{4}$	$\frac{29}{73}$

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* In partial averages the return of premium for convoy is not allowed on the amount claimed for average.

	£	s.	d.	
17.	16	12	$7\frac{1}{2}$	$\frac{1314}{1825}$
18.	3	1	$2\frac{3}{4}$	$\frac{37}{1825}$
19.	3	16	$10\frac{1}{2}$	$\frac{786}{1825}$
20.	9	9	$3\frac{0}{4}$	$\frac{146}{365}$
21.	9	3	$0\frac{3}{4}$	$\frac{201}{365}$
22.	3	15	$9\frac{1}{4}$	$\frac{239}{365}$
23.	792	17	$9\frac{3}{4}$	$\frac{117}{365}$
24.	914	2	$4\frac{1}{4}$	$\frac{287}{365}$
25.	882	2	$9\frac{3}{4}$	$\frac{261}{365}$
26.	612	4	0	
27.	796	9	$6\frac{1}{4}$	$\frac{43}{365}$
28.	882	5	$6\frac{1}{4}$	$\frac{47}{73}$
29.	263	12	$11\frac{1}{4}$	$\frac{87}{365}$
30.	154	9	$0\frac{0}{4}$	$\frac{48}{73}$
31.	640	0	$11\frac{3}{4}$	$\frac{293}{365}$
32.	725	7	$8\frac{1}{4}$	$\frac{291}{365}$
33.	232	10	$3\frac{1}{4}$	$\frac{247}{365}$
34.	3	13	$8\frac{1}{4}$	$\frac{248}{365}$
35.	9	4	$4\frac{3}{4}$	$\frac{7009}{9125}$
36.	11	12	$3\frac{1}{2}$	$\frac{10}{73}$
37.	139	17	$2\frac{1}{4}$	$\frac{3}{5}$
38.	8	6	$10\frac{0}{4}$	$\frac{1688}{1825}$
39.	13	13	$2\frac{1}{4}$	$\frac{1479}{1825}$
40.	13	13	$2\frac{0}{4}$	$\frac{176}{365}$
41.	36	8	$1\frac{1}{4}$	$\frac{19}{73}$
42.	68	13	$0\frac{1}{4}$	$\frac{291}{365}$
43.	17	2	$7\frac{3}{4}$	$\frac{157}{365}$
44.	6	18	$10\frac{1}{2}$	$\frac{64}{1825}$
45.	3	4	$9\frac{1}{4}$	$\frac{539}{1825}$
46.	4	1	$3\frac{3}{4}$	$\frac{813}{1825}$
47.	0	9	$6\frac{1}{4}$	$\frac{307}{365}$

48. $3\frac{1}{3}$ years
49. $5\frac{1}{2}$ years
50. $2\frac{1}{2}$ per cent.
51. 50; 40; $33\frac{1}{3}$; 20 and 15 years
52. 10; 8; 6; 4 and $2\frac{2}{3}$ per cent.
53. 3 per cent.
54. £424, 16s. 8d.

DISCOUNT.

	£	s.	d.	
1.	343	2	$8\frac{3}{4}$	$\frac{13}{17}$
2.	223	2	$9\frac{1}{2}$	$\frac{106}{121}$
3.	210	7	$11\frac{0}{4}$	$\frac{20}{101}$
4.	320	11	8	
5.	459	10	$3\frac{1}{4}$	$\frac{1}{3}$
6.	3	1	$3\frac{3}{4}$	$\frac{447}{1471}$
7.	2	9	$2\frac{0}{4}$	$\frac{40}{61}$
8.	4	10	$4\frac{1}{2}$	
9.	10	7	$4\frac{1}{2}$	
10.	122	17	0	
11.	25 per cent.			
12.	$2\frac{1}{2}$ years			
13.	£5, 2s. $2\frac{1}{4}$d. $\frac{7}{73}$			
14.	475	18	$6\frac{1}{4}$	$\frac{1068}{9125}$
15.	1	12	$2\frac{1}{2}$	$\frac{1238}{1825}$
16.	342	3	$2\frac{1}{4}$	$\frac{315}{365}$
17.	6	10	$0\frac{3}{4}$	$\frac{249}{365}$
18.	1239	15	$4\frac{1}{2}$	$\frac{66}{73}$

STOCKS.

1. £1573, 6s. 8d.
2. 8310 12 0
3. 1195 0 0
4. 823 14 6
5. £43, 13s. 4d.
6. India five per cents. which yield £4, 15s. $11\frac{11}{139}$d. p. c. p. an.

7. £60, 0s. 6d.
8. 441 4 10$\frac{3}{4}$ $\frac{13}{20}$
9. 125 per cent.
10. 243 per cent.
11. £13 gain
12. £23, 3s. 4d. yearly loss
13. £10815
14. 88$\frac{5}{8}$ per cent.
15. £3373, 13s. 0d.
16. 205 0 5$\frac{1}{2}$ $\frac{278}{1951}$
17. £389 income
18. £3, 16s. 2$\frac{1}{4}$d. $\frac{1}{7}$ per cent.
19. 109$\frac{1}{4}$ per cent.
20. £21, 13s. 3$\frac{3}{4}$d. $\frac{9}{41}$ yearly gain.

EQUATION OF PAYMENTS.

1. 77$\frac{7}{13}$ days
2. 238$\frac{14}{47}$ days
3. 283$\frac{46}{147}$ days
4. 188$\frac{2}{5}$ days
5. 133$\frac{92}{105}$ days
6. 16s. 6$\frac{1}{4}$d. $\frac{3}{29}$
7. 3s. 10$\frac{3}{4}$d. $\frac{7}{19}$
8. £2, 2s. 1$\frac{1}{2}$d. $\frac{6}{49}$
9. £1, 3s. 4$\frac{1}{5}$d.
10. 3s. 11d.
11. 14$\frac{11}{27}$ carats
12. 29·986 in.

PROFIT AND LOSS.

1. £33, 17s. 8d.
2. 21 7 6
3. 0 5 5$\frac{3}{17}$
4. 0 4 5$\frac{1}{4}$ $\frac{169}{257}$
5. 0 2 1$\frac{1}{4}$ $\frac{3}{13}$
6. 582 yd. 1 qr. 1$\frac{1}{3}$ nl.
7. 25 cwt. 1 qr. 26$\frac{46}{51}$ lb.
8. 242 cwt. 3 qr. 12 lb.
9. £4, 18s. 4d.
10. 3$\frac{3}{4}$d. $\frac{127}{273}$
11. 9$\frac{1}{11}$ per cent.
12. 10 per cent.
13. 26$\frac{6}{19}$ per cent.
14. 13$\frac{7}{11}$ per cent.
15. £11, 15s. 1d. or 56$\frac{12}{23}$ p. c.
16. 20$\frac{5}{6}$ per cent.
17. 19$\frac{27}{67}$ per cent.
18. 4s.
19. 13s. 6d.
20. 12s.
21. 4s. 9d.
22. 9d. per lb.
23. 4s. 10d. per lb
24. 3s. 8d. per yd.
25. 15s. per yd.
26. 5s. 6d. per lb.
27. 5$\frac{3}{4}$d. per lb.
28. 4s. per yd.
29. 9s. 6d. per yd.
30. £34$\frac{2}{5}$ per cent.
31. 19$\frac{3}{8}$ per cent.
32. 24$\frac{32}{93}$ per cent.
33. $\frac{4}{7}$ per cent. loss.
34. £896, 0s. 0d.
35. 872 10 0 prime cost
36. 5 4 8$\frac{8}{57}$ bought
    5 7 9$\frac{3}{4}$ $\frac{17}{57}$ sold
37. 2345 $\frac{5}{51}$ yd.
38. 1536$\frac{16}{69}$ lb.
39. £1, 14s. 4$\frac{3}{4}$d. $\frac{157}{193}$ pr. cost

PROMISCUOUS EXERCISES.

1. 17s. gain; $6\frac{2}{3}$ p. c.
2. £18, 4s. 6d.; 54 p. c.
3. 0 15 10; $5\frac{5}{9}$ p. c.
4. 0 9 $4\frac{1}{3}\,\frac{18}{19}$ per gal.
5. 28 19 10; $58\frac{1}{3}$ p. c.
6. 0 4 $7\frac{3}{4}\,\frac{101}{133}$ per lb.
7. 0 1 $0\frac{3}{4}\,\frac{3}{4}$ per lb.
8. $12\frac{22}{35}$ per cent.
9. 10s. $2\frac{3}{4}$d. $\frac{61}{95}$ per gal.
10. $3\frac{3}{4}$ per cent. loss
11. 10 per cent.
12. £61, 1s. gain
13. £$98\frac{1}{3}$ gain; $3\frac{567}{1781}$ p. c.
14. £200, 15s. 4d. gain
    £$8\frac{129376}{154405}$ gain p. c.
15. £104, 18s. 6d. gain
16. 960 yards at 3s.
17. $33\frac{1}{3}$ per cent.
18. 13s. $6\frac{1}{4}$d. $\frac{11}{35}$
19. $10\frac{19}{93}$ p. c. gain

	£	s.	d.	
20.	4	13	4	
21.	0	0	$9\frac{3}{4}$	$\frac{4569}{1050000}$
22.	0	18	$2\frac{1}{4}$	$\frac{41}{3775}$
23.	0	4	$6\frac{3}{4}$	$\frac{63}{83}$

24. £18·5879 gain p. c.
25. £0, 3s. $11\frac{3}{4}$d. $\frac{17}{23}$
26. 34·4022 gain p. c.
27. £9, 3s. 2d. loss.
28. £$7\cdot\dot{8}5714\dot{2}$ gain p. c.
29. £20 〃 〃
30. $15\frac{1}{3}$ 〃 〃
31. $14\frac{1}{6}$ loss 〃

DISTRIBUTIVE PROPORTION.

SIMPLE FELLOWSHIP.

1. 30, 40, 50
2. $106\frac{2}{3}$, 320, $533\frac{1}{3}$
3. A's £27, 17s. $5\frac{3}{4}$d. $\frac{4}{31}$
   B's 38 6 $5\frac{1}{4}$ $\frac{21}{31}$
   C's 41 16 $1\frac{1}{2}$ $\frac{6}{31}$
4. A's £94, 5s. $8\frac{1}{2}$d. $\frac{2}{7}$
   B's 62 17 $1\frac{1}{2}$ $\frac{6}{7}$
   C's 41 18 $1\frac{3}{4}$ $\frac{4}{7}$
   D's 20 19 $0\frac{1}{2}$ $\frac{2}{7}$
5. M's £37, 4s. $3\frac{3}{4}$d. $\frac{84}{89}$
   N's 52 8 $5\frac{1}{4}$ $\frac{51}{89}$
   P's 54 7 $3\frac{1}{4}$ $\frac{43}{89}$
6. B's £96, 8s. $2\frac{1}{4}$d. $\frac{11}{13}$
   C's 57 8 $8\frac{1}{2}$ $\frac{6}{13}$
   D's 86 3 $0\frac{3}{4}$ $\frac{9}{13}$
7. A's stock £300
   B's 480
   C's 420
8. L's 101 ac. 0 ro. $8\frac{8}{19}$ per.
   M's 88 1 $27\frac{7}{19}$
   N's 50 2 $4\frac{4}{19}$
9. 16s. 8d. per £1
   L, £625, 10s. 0d.
   M, 667 6 8
   N, 700 6 8
   O, 750 0 0
   P, 800 15 0
   Q, 833 19 2
10. 126, 135, 144, and 150 men
11. £84, 0s. 9d.
    126 1 $1\frac{1}{2}$
    168 1 6
    210 1 $10\frac{1}{2}$
    252 2 3

12. £207, 19s. 4d.
155 19 6
103 19 8
13. 14 lb. $2\frac{1}{2}$ oz. gold
1 $3\frac{1}{2}$ alloy
14. 14 lb. $4\frac{1}{20}$ oz. silver
1 $1\frac{19}{20}$ alloy

15. 13 cwt. 1 qr. 12 lb. nitre
2 1 14 charcoal
2 0 14 sulphur
16. A, £61, 0s. 0d.
B, 91 10 0
C, 114 7 6

COMPOUND FELLOWSHIP.

17. A's £60, 18s. $3\frac{1}{4}$d. $\frac{31}{197}$
B's 155 18 $9\frac{1}{4}$ $\frac{103}{197}$
C's 263 2 $11\frac{1}{4}$ $\frac{63}{197}$
18. A's £47, 8s. $4\frac{1}{4}$d. $\frac{349}{691}$
B's 113 19 $0\frac{0}{4}$ $\frac{528}{691}$
C's 92 12 $7\frac{1}{4}$ $\frac{505}{691}$
19. A's £68, 3s. $7\frac{1}{2}$d. $\frac{6}{11}$
B's 54 10 $10\frac{3}{4}$ $\frac{7}{11}$
C's 27 5 $5\frac{1}{4}$ $\frac{9}{11}$
20. A's £122, 11s. $0\frac{3}{4}$d. $\frac{3}{47}$
B's 114 17 $10\frac{1}{4}$ $\frac{41}{47}$
C's 122 11 $0\frac{3}{4}$ $\frac{3}{47}$
21. A's £10, 18s. $2\frac{2}{11}$d.
B's 12 5 $5\frac{5}{11}$
C's 6 16 $4\frac{4}{11}$

22. A's $4\frac{92}{97}$ months = $\frac{40}{97}$ yr.
B's $3\frac{9}{97}$ months = $\frac{25}{97}$ yr.
C's $3\frac{93}{97}$ months = $\frac{32}{97}$ yr.
23. 147 ac. 2 ro. 25 per.
151 0 32
147 2 25
148 3 14
24. 1st, 1848 rounds
2d, 1056 "
3d, 660 "
4th, 330 "
25. B, 5 oxen
26. B, £3500
C, 2400
D, 1800

EXCHANGE.

1. 496 fl. $50\frac{3}{10}$ kr.
1032 $11\frac{1}{2}$
2. £19, 17s. $2\frac{1}{2}$d. $\frac{2}{3}$
311 9 8
3. 9475 fr. $78\frac{9}{20}$ cents.
12833 $82\frac{3}{4}$
4. $3903{\cdot}57\frac{1}{7}$ dollars
$7591{\cdot}42\frac{6}{7}$
5. $29764{\cdot}06\frac{1}{4}$ kroner
45621·65

6. £120, 7s. $10\frac{1}{4}$d. $\frac{49}{103}$
202 16 $5\frac{0}{4}$ $\frac{52}{103}$
7. £610, 12s. $10\frac{3}{4}$d. $\frac{5}{49}$
620 15 $7\frac{0}{4}$ $\frac{212}{241}$
795 17 $7\frac{1}{2}$ $\frac{18}{49}$
809 1 $9\frac{3}{4}$ $\frac{153}{241}$
8. £5881, 14s. $7\frac{1}{2}$d. $\frac{1}{2}$
20782 7 $10\frac{1}{4}$ $\frac{1}{2}$
9. $12387\frac{19}{63}$ pesetas
$17031\frac{47}{63}$

10. 122383·65$\frac{1}{8}$ lire
219548·31$\frac{1}{18}$
11. 686 milr. 285$\frac{6}{7}$ reas
758 526$\frac{6}{19}$
841 904$\frac{16}{21}$
930 526$\frac{6}{19}$
12. 1851 fr. 75$\frac{1}{4}$ cents.
31640 22$\frac{1}{3}$
13. £189, 17s. 4$\frac{1}{2}$d. $\frac{2}{7}$
311 7 7$\frac{3}{4}$ $\frac{13}{21}$
14. 3028 lire 53$\frac{1}{6}$ cents.
2991 21$\frac{26}{48}$
134049 54$\frac{7}{15}$
132397 90$\frac{1}{12}$
15. £4185, 16s. 11$\frac{1}{2}$d. $\frac{3}{5}$
4242 8 3$\frac{1}{4}$ $\frac{1}{2}$
4651 8 9$\frac{1}{2}$
4714 5 11$\frac{1}{4}$
16. £851 6s. 7$\frac{3}{4}$d. $\frac{1}{5}$
4938 17 0$\frac{1}{4}$ $\frac{1}{5}$
17. £865 15s. 7$\frac{0}{4}$d. $\frac{36}{43}$
18. £9 18s. 4$\frac{3}{4}$d. $\frac{97}{101}$
9 18 6$\frac{3}{4}$ $\frac{429}{841}$
19. 4503 r. 1 an. 2$\frac{10}{13}$ pice
4390 8 0
20. 8776·05 kroner
21. £617, 3s. 9d.
22. £25.

ARBITRATION OF EXCHANGE.

1. 560 English yards
210 Hamburg yards
2. 20 marks per £1
3. 11·98$\frac{1}{2}$ florins 〃
4. 24·25$\frac{25}{27}$ francs 〃
5. 24·28$\frac{4}{7}$ francs 〃
6. £600
7. 27219 marks
8. £2, 10s. 6$\frac{6}{19}$d.
9. 120 lines
10. 330 lb. of sugar
11. 10 points
12. 14 days of E.

PROMISCUOUS EXERCISES IN EXCHANGE.

1. 5637·5 dollars
2. £144
3. £2149
4. £1618, 0s. 3$\frac{1}{4}$d. $\frac{193}{299}$
5. 11 fl. 98 c. per £1
6. £74, 13s. 10$\frac{3}{4}$d. $\frac{917}{1009}$
7. £925, 12s. 2$\frac{1}{4}$d. $\frac{15}{41}$
8. 2889·60 florins
9. £5·976 gain
10. £20 loss
11. £127·660 gain
2·1276 gain p. c.
12. £759, 12s.
13. £60 gain
1$\frac{3}{17}$ gain p. c.
14. £140, 12s. 6d. gain
18·75 gain p. c.
15. £442, 15s. 5d.
16. 182699·4496 kroner
17. Direct, £80; By Holland, £82, 12s.

18. £5820
19. Direct, £912, 10s.,
On Holland, £907, 13s. $11\frac{1}{4}$d. $\frac{9}{19}$
On Hamburg, £923, 4s. $8\frac{1}{4}$d. $\frac{15}{17}$
20. £58·656
21. Direct, £2491, 13s. 4d.
By Holland, £2529, 5s.
22. A lost, 24·664 francs
23. Loss, 4·3735
24. Direct, £85
On Holland, £87·98775
25. Direct, £352, 17s. $1\frac{1}{2}$d. $\frac{6}{7}$
Through Holland, £360, 13s. 8d.
Through Hamburg, £362, 18s. 4d.
26. E gained, £1·288
27. £347, 0s. $2\frac{1}{2}$d.

ALLIGATION.

1. $5\frac{1}{2}$d. $\frac{3}{5}$ per lb.
2. 4s. $1\frac{3}{4}$d. $\frac{1}{9}$
3. 7s. 9d. per gal.
4. 5s. $9\frac{1}{4}$d. $\frac{6}{7}$ per gal.
5. 4s. $9\frac{1}{5}$d. per gal.
6. $17\frac{1}{6}$ carats fine
7. 2 bu. at 30 d. 3 bu. at 40 d.
8. Equal quantities
9. 1lb. at 4d. & 6d., 6lb. at 9d.
10. 6 gal. at 8s., 1 gal. of rest
11. 5 gal. of spirits to 1 gal. of water
12. Same no. of boys, and girls, and twice that no. of men and women
13. 16 at 6s., 4 at the rest
14. 20 at 9s., 10 at the rest
15. $3\frac{1}{8}$ oz. of gold 9, 12, and 15 carats fine
$7\frac{13}{18}$ oz. of gold 18 and 22 carats fine
16. $7\frac{1}{5}$ oz. of copper and silver with $50\frac{3}{5}$ oz. of gold
17. 6 at 5s. and 6s., 18 at rest
18. 6 at 8s. and 9s., 18 at rest
19. 3 at 4s., 6 at 6s., 12 at 5s. and 24 at 5s. 6d.
20. 12 lb. at 2d., 3d., 4d., and 5d., and 48 lb. at 6d and 7d.

POSITION.

1. 60 number required
2. £36 value of horse
3. 36 years of age
4. 60 number required
5. 80 apple, 60 pear, 48 plum, 64 cherry trees
6. £525 the sum
7. £72·4; £45·25; £36·2
8. 31500 men
9. £252; £189; £151·2; £126
10. 20 number required
11. A $£11\frac{1}{13}$, B $£11\frac{6}{13}$, C $£13\frac{7}{13}$
12. 15 number required
13. 35 at 8s., 25 at 10s.
14. 72 crowns
15. 12 beggars
16. £20 buying price
17. 9 days idle

INVOLUTION.

1. 529
15625
$177\frac{7}{9}$
$\frac{49}{81}$
$156\frac{1}{4}$
·00005625

2. 3375
19683
$75418\frac{57}{64}$
$\frac{64}{125}$
·001953125
·000000244140625

3. 28629151
·004096
$\frac{2187}{78125}$
·000000390625
$\frac{3125}{7776}$
11·390625

4. 1444 s. in.
5. 125 c. ft.
6. 3375 cubes
7. 6 to. 2 qr. 4 lb.
8. $1711\frac{709}{1105}$ gal.

EVOLUTION.

EXTRACTION OF THE SQUARE ROOT.

1. 24
2. 144
3. 789
4. 888
5. 1111
6. 9748
7. ·73
8. 2·42384
9. 698·343
10. 956·49
11. 2480·795
12. 2·236067977
3·31662479
13. 4·16
14. ·91
15. $\frac{7}{12}$ and $\frac{9}{11}$
16. ·8660254 and $\frac{23}{38}$
17. ·027
18. 28·00669
19. 8·26639784
20. 22·04792759
21. ·0028
22. 70809
23. ·000073
24. 1001001
25. 500403
26. 8070405

27. 123456789

28. 12; 13; 12; 25; 30·74085; 1·272792

29. ·886228 side
30. 21·9089 poles
31. 138·564 poles
32. 44·07947 poles
33. 56·28499 poles
34. 4896 feet
35. 134·164 yards
36. 30·9838 feet
37. £431, 0s. $9\frac{1}{4}$d. $\frac{2}{5}$
38. 807 trees in br.
39. 49·598 poles
40. 9 + 16 = 25
41. 215·4 feet high
42. 375 ft. broad
43. 334·185577 ft.
44. 203·0394 ml.
45. 139·082 feet

46. 89 men in the side
445 men in front
47. 216 men; £36
48. 42·4264 ft.
49. 21·9317 ft.
50. 62·2254 yd. broad
311·1271 yd. long

EXTRACTION OF THE CUBE ROOT.

1. 25
2. 276
3. 375
4. 7889
5. 111111
6. 4070809
7. 6031
8. 7008409
9. ·345
10. 7856
11. 18·93049
12. 19·86228
13. 1·44225
    1·912931
14. ·0045
15. 9·2235
16. 41·3782
17. ·097208
18. $\frac{6}{7}$, $\frac{5}{9}$, $\frac{12}{13}$
19. 300303
20. 22·5
21. 66·6059 feet
22. 254·446 feet
23. 16·64067 inch
24. 5·769, 4·81, 3·61 ft.
25. 381$\frac{1}{9}$ lb.
26. 36·63 inches
27. 17·235 ft. long
    12·927 ft. broad
    8·618 ft. thick
    12·83 ft. side of cube

EXTRACTION OF ANY ROOT.

1. 3·1412
2. 1·2457
3. 32
4. 48
5. 19·87759
6. 5·252
7. 1·62657
8. 1·5517
9. 1·30766
10. ·0786014
11. 24
12. 1·5849
13. ·85475
14. ·8393784
15. 1·5229
16. 1·87446

SERIES OR PROGRESSIONS.

ARITHMETICAL PROGRESSION.

1. 3 diff.; 297 sum
2. 4 diff.; 351s. debt
3. 4 diff.; £995 price
4. 25 No.; 1375 sum
5. 31 rows; 961 trees
6. 11 poor; 15s. 7d.
7. 19 days; 627 miles
8. 7 least; 23 greatest
9. 4s. 6d. least; 157s. 6d. gr.
10. 2 least; 44 greatest
11. £2 least; £20 greatest
12. 42 greatest; 297 sum
13. 8 least; 1572 sum
14. 47s. greatest; £15 divided
15. 7 miles first day; 420 miles

GEOMETRICAL PROGRESSION.

1. 384 greatest
2. 1215 greatest
3. 162; 4374
4. $\frac{1}{64}$; $\frac{1}{1024}$
5. ·002; ·00002
6. £8, 10s. 8d. paid
7. £164, 0s. 6d. for all
   £10, 18s. 8$\frac{2}{3}$d. for each
8. 3280 the sum
9. 635 the sum

10.	$\frac{364}{1215}$ the sum	15.	100 miles
11.	£4095, 15s. debt	16.	$\frac{7}{9}$ mile
12.	£1968, 4s.	17.	1 value
13.	$\frac{1}{3}$ the sum	18.	$\frac{4}{9}$ 〃
14.	$\frac{1}{8}$ the sum	19.	$\frac{5}{6}$ 〃

20. $\frac{7}{12}$ the value

PERMUTATIONS AND COMBINATIONS.

1.	620448401733239439360000	13.	5005
			352716
2.	362880	14.	725887853745600
3.	3628800	15.	635013559600
4.	479001600 days	16.	£18031572350, 9s. 2d.
	£778377600	17.	502
5.	9081072000	18.	67108837
6.	15120	19.	120
7.	1680	20.	4503599627370443
8.	92400	21.	3905
9.	504	22.	435848049
	15120	23.	6134716369305281647450180641
10.	95040		
	20160	24.	328114698808273
	362880	25.	28561
11.	90	26.	7776
12.	7893600	27.	1331
13.	495	28.	16384

COMPOUND INTEREST.

	£	s.	d.		£	s.	d.
1.	463	1	0	5.	97	0	6
2.	720	6	6	6.	154	15	3¼
3.	973	6	5	7.	91	18	11½
4.	975	3	10	8.	51	13	6
	976	3	0¼*	9.	663	2	1

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* In finding the amount or present worth when the interest is payable either half-yearly or quarterly, the common method is to take ½ or ¼ of the rate of interest, and then compute as directed in

	£	s.	d.		£	s.	d.
10.	128	18	$5\frac{1}{4}$	15.	853	9	$9\frac{3}{4}$
11.	236	8	$11\frac{1}{2}$	16.	788	16	$0\frac{1}{4}$
12.	252	7	7	17.	323	3	$8\frac{3}{4}$
13.	1003	6	$6\frac{1}{4}$	18.	12	7	11
14.	811	6	$11\frac{3}{4}$	19.	381	13	$2\frac{1}{4}$

ANNUITIES.

ANNUITIES CERTAIN.

	£	s.	d.		£	s.	d.
1.	169	17	$2\frac{1}{2}$	25.	1666	13	4
2.	171	13	2	26.	600	0	0
3.	172	5	2	27.	454	5	$5\frac{3}{4}$ $\frac{1}{3}$
4.	754	13	$5\frac{3}{4}$	28.	993	10	$8\frac{3}{4}$
5.	432	19	0	29.	15 years		
6.	543	12	$2\frac{3}{4}$	30.	16 years		
7.	846	0	$6\frac{1}{2}$	31.	18 years		
8.	555	4	$9\frac{1}{2}$	32.	$13\frac{1}{3}$ years		
9.	803	13	$2\frac{1}{4}$	33.	£5 per cent.		
10.	3825	7	$0\frac{3}{4}$	34.	$6\frac{2}{3}$ per cent.		
11.	641	0	4	35.	$5\frac{6}{11}$ per cent.		
12.	418	13	0	36.	$7\frac{17}{19}$ per cent.		
13.	5000	0	0	37.	20 years		
14.	12500	0	0	38.	$22\frac{2}{3}$ years		
15.	26666	13	4	39.	$26\frac{2}{3}$ years		
16.	120000	0	0	40.	$11\frac{13}{17}$ years		
17.	250	0	0	41.	£3731,	1s.	6d.
18.	45	0	0	42.	10274	1	9
19.	100	0	0	43.	6393	10	9
20.	100	0	0	44.	17171	7	$11\frac{1}{2}$
21.	6 per cent.			45.	62	15	$8\frac{1}{2}$
22.	6 per cent.			46.	651	11	$1\frac{1}{2}$
23.	4 per cent.			47.	393	11	4
24.	$4\frac{1}{3}$ per cent			48.	6077	11	0

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the rule; the most correct method, however, especially in the calculation of annuities, is to take the square root of the amount of £1 for a year when the payments are half-yearly, and the fourth root of that amount when the payments are quarterly for the amount of £1 for the half or the quarter of a year.

CONTINGENT OR LIFE ANNUITIES.

1. 17·9956 years
2. 27·7594 years
3. 30·8515 years
25·6865 years
20·5289 years
6·5433 years
4. 39·7818 years
33·4351 years
28·2760 years
23·0785 years
5. $\frac{2038}{3635}$ probability
6. $\frac{291627}{417452}$ probability
7. $\frac{1068089869}{5672945260}$ probability
8. $\frac{1617674927104}{2337065589449}$ probabil.
9. $\frac{642093}{890155}$ probability
10. $\frac{3432679}{4500764}$ probability
11. $\frac{2382739}{2505589}$ probability
12. $\frac{6286650}{6957709}$ probability
13. £1123·28
14. 1026·9
15. 2130·66
16. 3458·25
17. 1·600
18. 185·2
19. 221·125
20. 356·1
21. 492·011
22. 581·85
23. 163·529
24. 246·28
25. 1143·4
26. 654
27. 1126·92
28. 1366·32
29. 1798·8
30. 900·48
31. £2007·24
32. 4108
33. 2325
34. 4174·96
35. 2686·68
36. 9857
37. 2037·7
38. 2876·1
39. 4748·5
40. 2297·25
41. 3387·6
42. 4649·1
43. 1454·22
44. 189·8
45. 447·6
46. 325·6
47. 724·2
48. 155·68
49. 169·04
50. 190·1
51. 4·438 years' purchase
52. £1222·78846 value
92·0566 annually
53. 912·9846 value
67·9506 annually
54. 1034·7619 value
55. 183·8095 value
56. 280·03846 value
57. 266·712 value
58. 5108·5 value
59. 23835 value
60. 12573 value
61. 29124 value
62. 8066 value
63. 50·89 annually

PROMISCUOUS EXERCISES.

1. £452·7 present value
2. 29·89 annually
3. 44·1113 annually
4. 26·6806 annually
5. 34·9914 annually
6. 3·19759 annually
7. 265·02 present value
8. 90·839 annually
9. 1390·200 value
10. £3827·4 payment
11. 6560·100 value
12. 285·98 present value
13. 0·3209 annually
14. 12·1414 annually
15. 7·825 annually
16. 4·8591 annually*
17. 16·256 fine
18. 8·790 fine

DUODECIMAL MULTIPLICATION.

	sq. ft.	sq. in.
1.	161	96
2.	540	54
3.	4341	91
4.	966	132
5.	8617	4
6.	1279	99
7.	5370	$83\frac{1}{3}$
8.	444	$70\frac{1}{2}$
9.	392	$122\frac{1}{6}$
10.	671	$113\frac{1}{12}$
11.	1036	$10\frac{2}{3}$
12.	819	$113\frac{1}{6}$
13.	1048	$84\frac{1}{12}$
14.	606	$127\frac{1}{2}$
15.	557	$42\frac{1}{3}$
16.	881	$84\frac{13}{16}$
17.	249	$108\frac{4}{9}$
18.	4014	$85\frac{13}{18}$
19.	2960	$112\frac{1}{9}$
20.	4339	$55\frac{1}{3}$
21.	2463	$51\frac{8}{9}$
22.	5414	$117\frac{13}{16}$

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* As this and the two following exercises do not fall under any of the Problems, it may be necessary to state the methods by which they are computed. In the 16th, Find the value, supposing them 5 years older, and multiply it by the present value of £1 due 5 years hence, and also by the probability that both will be alive at the end of 5 years, for the present value of an annuity of £1, with which proceed as before.—17th, Take the difference between the real value and the value, supposing their ages to be equal; multiply this by the value of the husband's life and by the annual contribution, and divide the product by the value when their ages are equal.—18th, Multiply the difference between the values of two lives, the one of 35 and the other of 45 years by the annual contribution.

ARTIFICERS' MEASURING.

Prob. I.

	s. ft.	s. in.
1.	15	90
2.	150	25
3.	36	42
4.	44	8
5.	102	32
6.	25	72½

Prob. II.

	c. ft.	c. in.
1.	61	1512
2.	28	1302
3.	414	1452
4.	4247	594
5.	41	216
6.	35	577$\frac{1}{13}$

Problem III.

1. 116 c.ft. 648 c. in. by rule I.
   148·96 true content
2. 96, by rule I.
   122·88 true content
3. 153·125, by rule I.
   196 true content
4. 31·6875 feet, by rule I.
   40·56 true content
5. 41·847$\dot{2}$ by rule I.
   53·56$\dot{4}$ true content
6. 42·519525, by rule I.
   54·424992 true content

EXERCISES.

1. 1182 s. ft. 32 s. in.
2. 3984 126
3. 37 6⅛
4. 65782$\frac{60866}{138637}$ gall.
5. 526259$\frac{71017}{138637}$ gall.
6. 181 c. ft. 867 c. in.
7. 302 s. ft. 122 s. in.
8. 201 88
9. 288 89
10. 35 c. ft. 851$\frac{29}{56}$ c. in.
11. £9, 18s. 0¼d. $\frac{47}{64}$
12. 20 3 9¼ $\frac{1}{3}$
13. 5 3 2½ $\frac{13}{28}$
14. 40 15 7½
15. 0 2 9¾ $\frac{6}{13}$
16. 262 s. yd. 4 ft. 72 in.
17. 71 7 142⅜
18. £33, 18s. 1¾d. $\frac{1}{5}$
19. £230, 15s. 9$\frac{8}{27}$d.

MISCELLANEOUS QUESTIONS.

1. 108110040736$\frac{32}{163}$ casks
   88109683200000 herring
2. 1s. 1½d. share, 4th class
   4s. 6d. 〃 3d 〃
   13s. 6d. 〃 2d 〃
   27s. 0d. 〃 1st 〃
3. £62, 14s. 0¼d. ½
4. £11, 6s. 3¼d. gain
5. $\frac{16}{117} = \cdot\dot{1}3675\dot{2}$
6. £74, 7s. 2½d.
7. 7604⅛ ac. for 5000 families;
   5513020⅝ ac. for U. K.
8. ·625; ·21875
9. £92, 15s. 8¼d. ⅗ debt

10. 500 yds. sold at 17s. 8d.
11. 1st sh. £23, 13s. 5$\frac{2}{4}$d. $\frac{1693}{2471}$
2d sh. £35, 4s. 2$\frac{2}{4}$d. $\frac{200}{2471}$
3d sh. £41, 2s. 4$\frac{2}{4}$d. $\frac{688}{2471}$
12. 3s. 2$\frac{1}{4}$d. $\frac{21}{48}$ per lb. tea
13. 14$\frac{177}{184}$ gall. brandy
14. £30, 4s. 10$\frac{1}{2}$d. $\frac{6}{41}$ gain
15. 2005$\frac{1}{5}$ lb. cotton
16. 8s. 8$\frac{1}{2}$d. $\frac{3}{5}$ per gall.
17. A's advantage $\frac{6}{11}$d. p. gal.
18. D gives 985$\frac{3}{5}$ yards, and has $\frac{2}{3}$d. advantage
19. £1, 6s. 7$\frac{1}{2}$d. gain
20. 7s. 9$\frac{11}{23}$d. per yard
21. £2, 5s. received in money
22. £151, 13s. 0$\frac{1}{4}$d. $\frac{3}{5}$ val. rec.
23. 4c. 2q. 12$\frac{1}{30}$lb. at 15d. p. lb.
24. 7s. 1$\frac{3}{4}$d. $\frac{3}{517}$ per gal. rum
8s. 3$\frac{3}{4}$d. $\frac{3}{517}$ p. gal. brandy
25. £1, 6s. 8$\frac{1}{4}$d. $\frac{1}{3}$ p. qr. barley
26. 3$\frac{3}{5}$ month after $\frac{1}{2}$ year
One year, £126, 15s.
27. £43, 3s. 9$\frac{3}{4}$d. gain
28. 4 mo. 20$\frac{287}{385}$ days voyage
29. £10, 2s. 0$\frac{1}{4}$d. $\frac{189}{508}$ freight
30. Captain, £699, 6s. 0d.
1st mate, &c. 492 2 0
2d mate, 388 10 0
Sailor, 97 2 6
Marine, 66 12 0
31. £14374, 10s. income
32. Wife's share, £240
First son's, 460
Second, 320
Third, 180
33. First share, £115, 12s. 6d.
Second, 192 14 2
Third, 269 15 10
Fourth, 346 17 6
Fifth, 423 19 2
Sixth, 501 0 10
34. A's share, 8s. 2$\frac{3}{11}$d.
B's, 5 5$\frac{5}{11}$
C's, 4 1$\frac{1}{11}$
D's, 3 3$\frac{3}{11}$
35. E's, £440; F's, £293$\frac{1}{3}$
36. 21$\frac{2}{3}$ minutes in all
37. 7 days idle
38. 11$\frac{127}{440}$
39. 86° F.; 5° C.
40. £537, 19s. 7d.
41. 984 number
42. 117 first term
43. 5s. gain
44. 2$\frac{1}{2}$ per cent.
45. 18150 number
46. £389, 6s. 6d.
47. 4 3 10$\frac{1}{2}$ $\frac{12}{83}$ sell. pr.
48. $\frac{16}{55}$ = £536, 18s. 7$\frac{7}{11}$d.;
part sold = £813, 1s. 4$\frac{4}{11}$d.
49. 27$\frac{9}{13}$ hours
50. 84 men; 56 wom.; 14 boys
51. 465 number
52. $\frac{5}{9} = \cdot\dot{5}$; $\frac{25}{111} = \cdot\dot{2}2\dot{5}$
53. 27$\frac{173}{2401}$ the fraction
54. 72, second term
55. 2$\frac{3}{4}$ years
56. 10s. paid by each
57. 6640 families
58. 398 c. ft. 636 c. in. content
59. 163 1080 content
60. 65 1586$\frac{1}{4}$ content
84 648 true content
61. 40 1211$\frac{1}{4}$ content
52 168 true content
62. 15 262$\frac{1}{8}$ content
19 681$\frac{3}{25}$ true cont.
63. 61 c. ft. 1263 c. in. cont.
79 26 $\frac{22}{25}$ true cont.
64. 119 336$\frac{3}{4}$ content
152 984 true cont.

65. 84 s.yd.3 s.ft.48 s.in.surf.
66. £383, 0s. $10\frac{2}{25}$d.
67. 324 gallons
68. 133s.yd.1s.ft.96s.in surf.
69. 102 2 3 content
70. 20002 ; $\frac{11}{12}$
71. £55, 13s. yearly gain
72. 103·9 s. ft.; £238·97 val.
73. 155 s. yd. $3\frac{1}{6}$ s. ft.; £12, 18s. $11\frac{1}{27}$d. value
74. $3\frac{3}{5}$ days
75. 202002
76. 34 yards plastering
77. $1\frac{3}{5}$ rood mason work
78. 46 cwt. 1 qr. 15 lb. 5 oz.
79. 55 yards
80. $7\frac{1}{2}$ roods, value £12
81. 3 roods at 30s. = £4, 10s.
82. 248 s. yd. 8 s. ft. content
83. 6 at 3s. 4d. to 2 at 4s.
84. A, £575, 12s. 6d.
B, £489, 16s. 8d.
85. £2400 original amount
86. 339 s. yd. $4\frac{5}{9}$ s. ft. cont.
87. 49 s.ft. 72 s.in. hewn work
88. 1060·66 yards
89. £1, 5s. $7\frac{3}{4}$d.
90. 567 sq. ft. 48 sq. in.
91. 29260 yards, val. £792, 9s. 2d.
92. 200 qrs.
93. 40 years
94. 184 s. ft. 36 sq. in.; £7, 9s. $8\frac{1}{4}$d. $\frac{3}{4}$
95. 42 deals
96. Ceiling, $278{\cdot}486\dot{1}$ yards
Value, £9, 5s. $7\frac{3}{4}$d. $\frac{5}{8}$
Sides, $391{\cdot}91\dot{6}$ yards
Value, £4, 17s. $11\frac{3}{4}$d.
97. $90\frac{7}{80}$ deals
98. 108 cubic yards
99. $415\frac{5}{9}$ yards, value £25, 19s. $5\frac{1}{3}$d.
100. £4750, 12s. 6d.
101. 50 at 13s. 4d.
34 at 16s. 8d.
102. 1500 men
103. 87 h. cr.; 3 fl.
104. 2 h. 20 m. after 2d.
105. 11, 35, and 20 gal. p. m.
106. 3 days after B.

107. $31640\frac{3}{8}$ lbs. weight on a man
11699086162500000000 lbs. weight of the atmosphere
108. $25540941723468387096 77\frac{13}{31}$ lb. salt water in the sea
$743910923984516129 03\frac{7}{31}$ lb. salt in the sea
109. 4·874 dol. per £1, or $9\frac{3}{4}$ per cent. prem. nearly
110. 12·02 florins per £1
111. $w = 5 \times 100 \times \frac{1}{10} = 50$, $d = 5 \times 100 \times \frac{1}{50} = 10$,
$D = 50 \times 10 \times \frac{1}{5} = 100$, $p = 50 \times 10 \times \frac{1}{100} = 5$
112. and 113. are wrought in the same way as Quest. 111.
114. 12 inches, 16 inches, 20 inches, etc.

115. 105·30154 lb.
116. $1302\frac{3}{4}$ feet
117. 6·108 sec.
118. $6433\frac{1}{3}$ feet
119. 579 feet
120. 34260 ft.

121. $32\frac{308}{571}$ seconds

122. If we suppose that it is 1 degree at the earth; then at Mercury it is $6\frac{811}{1369}$, at Venus it is $1\frac{4264}{4761}$, at Mars it is $\frac{361}{841}$, at Jupiter $\frac{361}{9801}$, at Saturn $\frac{9025}{822649}$, and at Uranus $\frac{9025}{3323329}$; or if we suppose that it is 1 degree at Uranus, then at Saturn it is $4\frac{32733}{822649}$, at Jupiter it is $13\frac{138004}{245025}$, at Mars it is $158\frac{1379}{21025}$, at the Earth it is $368\frac{2129}{9025}$, at Venus it is $698\frac{151}{4761}$, and at Mercury it is $2427\frac{766}{1369}$

DECIMAL COINAGE.

1.	£79·200	4.	£96·600	7.	£136·520	10.	£135·802
2.	97·500	5.	110·780	8.	163·400	11.	315·040
3.	69·800	6.	101·090	9.	153·986	12.	513·007

13.	£84,	2fl.	0c.	0m.	19.	£213,	3fl.	0c.	5m.
14.	48	3	4	0	20.	312	0	4	8
15.	96	2	5	7	21.	572	8	6	7
16.	108	0	2	5	22.	257	4	8	0
17.	123	0	0	7	23.	752	0	2	5
18.	132	1	7	4	24.	572	0	0	9

25.	£498·464	32.	£487·877	39.	£5317·200	46.	£223·284
26.	3306·818	33.	487·854	40.	8118·528	47.	567·431
27.	4720·605	34.	84·667	41.	6640·821	48.	1425·665
28.	5171·096	35.	486·265	42.	9268·930	49.	2461·875
29.	3045·577	36.	298·788	43.	5991·804	50.	9011·898
30.	5204·593	37.	764·343	44.	8594·928	51.	15306·952
31.	438·829	38.	1846·026	45.	150·024	52.	27904·633

53.	£8·724	57.	£13·891	61.	£17·824	65.	£17·942
54.	9·875	58.	15·797	62.	21·802	66.	15·123
55.	11·473	59.	14·395	63.	27·317	67.	9·873
56.	12·782	60.	7·893	64.	15·963	68.	12·965

69.	£·425	73.	£·875	77.	£9·8333	81.	£29·28125
70.	·6125	74.	·9166̇	78.	10·775	82.	47·3333̇
71.	·6666̇	75.	4·125	79.	14·8125	83.	59·42083̇
72.	·7875	76.	7·1875	80.	19·8833̇	84.	79·8125

85.	£85·775	86.	£98·0833̇

	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
87.	12	6	91.	0	19	8	95.	9	16	8	99.	29	19	1
88.	15	6	92.	0	10	4	96.	12	6	8	100.	47	14	3¾
89.	17	1	93.	4	11	8	97.	14	18	8½	101.	58	11	7¾
90.	7	6	94.	7	13	4	98.	17	13	8	102.	77	6	6¾

103. £84, 9s. 8d. | 104. £99, 0s. 8d.

PRACTICAL EXERCISES.

1. £149·889
2. 1·369
3. 1·225
4. 1·775
5. 135·375
6. 5·675
7. 125 oz.
8. £388·875
9. 202·500
10. 2·520
11. ·030
12. 9209·600
13. 45 men
14. $3\frac{1}{3}$ ye.
15. £17·500
16. $\frac{7}{12}$
17. ·512
18. £252·350
19. 90·4995
20. 6063·242
21. 32·760
22. 568·575
23. 172·500
24. 9·424
25. 185
26. 4 p. c.
27. 512 days
28. £12·3375
29. 878·559
30. 7541·622
31. £6658·050
32. ·192
33. 323·0400
262·9440
381·9456
390·6624
416·3520
34. 542·720
407·040
271·360
162·816
35. 67·756
101·634
135·512
169·390
36. £36·975
37. 659·2502
38. 485·625
39. 4·443
40. 692·584
41. 243·7335
42. 729 of each
43. £525·624
479·865
44. 9 p. c.
45. 187 yds.
46. £364·815
47. $\frac{6}{25}$ & £817·2
48. £4053·144
49. 4 p. c.

METRIC SYSTEM.

1. 10,000 centimetres
2. 10,000,000 millimetres
3. 9754 metres; 9,754,000 millimetres
4. 9 metres, 6 decimetres; 3 dekametres, 9 metres, 4 decim. 5 centimetres; 4 kilom. 7 dekam. 5 metres, 3 decim. 9 centim. 5 millimetres
5. 10,000,000 centiares
6. 1000 square metres
7. 75300·84 ares
8. 4 hectar. 9 dekar. 7 ares; 7 hectar. 3 dekar. 4 ar. 8 deciar.; 9 hectar. 7 dekar. 5 ar. 45 centiar.
9. 500,000 centisteres
10. 10,000 cubic decimetres
11. 957·5 steres
12. 57 dekast. 5 steres; 5 dekast. 7 steres, 5 decisteres; 5 steres, 7 decist. 5 centist.
13. 5000 decilitres
14. 10,000,000 cub. centim.
15. 120,000 cub. centimet.
16. 45075·25 litres
17. 1,250,175 centilitres
18. 9 kilol. 6 hectol. 5 dekal. 4 lit.; 9 dekal. 4 lit. 2 decil. 5 centil.; 3 hectol. 7 dekal. 5 litres
19. 7 dekalit. 9 lit. 5 decilit. 4 centilit.; 4 dekal. 6 lit. 8 decil. 7 centil. 5 millil.
20. 10,000 decigrams
21. 10,000 milligrams
22. 100,000 centigrams
23. 7502·5 grams
24. 40,750 milligrams
25. 907,040 centigrams
26. 8,700,000 grams
27. 7 hectog. 3 dekag. 5 gr. 7 decig. 5 centig.; 9 kilog. 7 hectog. 5 dekag. 4 grams, 2 decig. 5 centig.
28. 3 kilog. 7 hectog. 5 dekag.; 7 hectog. 4 dekag. 8 grams. 9 decig. 5 centigrams
29. 3 hectog. 7 dekag. 5 grams, 4 decig. 6 centigrams; 3 hectog. 6 dekag. 9 grams, 5 decig. 4 centig. 8 millig.
30. 37,500 centimes
31. 756 francs, 2 decimes, 5 centimes; 3456 francs, 7 decimes, 5 centimes
32. 18412·305 metres
33. 10272·732 metres
34. 72392·245 ares
35. 77443·45 ares
36. 261·625 steres
37. 37181·25 litres
38. 129847·85 litres
39. 151410·598 grams
40. 22289·79 francs
41. 57553·5 metres
42. 16859·5 ares
43. 988·25 steres

44. 685994·99 litres
45. 715994·2 grams
46. 3752621·29 grams
47. 1958·47 francs
48. 2968·3 francs
49. 360·4 metres
833·425 „
957·3125 „
50. 60051·6 ares
107592·45 „
9383·0625 „
51. 19541·2 steres
21634·9 „
16575·125 „
52. 1809176·4 litres
1985068·55 „
61562·2525 „
53. 3251967·75 grams
3573149·75 „
137305·305 „
54. 19212072·0 grams
20212700·75 „
850534·4375 „
55. 433199·25 francs
485708·25 „
10808·1025 „
56. 161·11 metres
85·69$\frac{22}{47}$ „
1643·97$\frac{47}{48}$ „
57. 1061·19$\frac{4}{5}$ litres
757·99$\frac{38}{63}$ „
1949·13$\frac{13}{48}$ „
58. 55787·57$\frac{11}{12}$ grams
45852·80$\frac{35}{78}$ „
91705·60$\frac{70}{78}$ „
59. 928676$\frac{7}{8}$ grams
1198292$\frac{28}{31}$ „
10177280$\frac{60}{78}$ „
60. 1070·25 francs
871·13$\frac{18}{43}$ „
472·36$\frac{602}{783}$ „

THE END.

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